ENVIRONMENTAL QUALITY INCENTIVES PROGRAM

AS PART OF THE

FEDERAL AGRICULTURE IMPROVEMENT AND REFORM ACT
(The 1996 Farm Bill)

ENVIRONMENTAL RISK ASSESSMENT

FINAL

February 11, 1997

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EXECUTIVE SUMMARY

There are four environmental mandates in the Environmental Quality Incentives Program (EQIP): combine into a single program the functions of the rescinded Agricultural Conservation Program (ACP), the Great Plains Conservation Program (GPCP), the Water Quality Incentives Program (WQIP), and the Colorado River Basin Salinity Control Program (CRSCP); execute the EQIP in a manner that maximizes environmental benefits per dollar expended; provide flexible technical and financial assistance to farmers and ranchers who face the most serious threats to soil, water and related natural resources, including those threats to grazing lands, wetlands and wildlife habitats; and provide assistance to farmers and ranchers to comply with the Conservation Title of the 1996 Farm Bill and other Federal and State environmental laws.

The Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994 requires that a risk assessment of the EQIP be conducted because EQIP represents a major regulation, with current funding at levels exceeding $100 million annually; and the EQIP represents a program that could have significant effects upon human health, safety, and the environment. This document fulfills the requirements of the Act, as currently understood.

A team of Natural Resources Conservation Service (NRCS) personnel worked to create the EQIP risk assessment in cooperation with USDA's Office of Risk Assessment and Cost Benefit Analysis (ORACBA). The NRCS team determined that there are significant risks to on-farm and off-site environments as a result of agricultural production activities.

This report consists of technical evaluations and analyses that attempt to characterize the relationships between agricultural production activities, ecosystem stressors and resulting adverse ecological effects on particular natural resources. The report consists of four sections: 1) Introduction; 2) Problem Formulation; 3) Analysis of Ecological Effects; and 4) Risk Characterization.

In creating the EQIP, Congress, in the Federal Agriculture Improvement and Reform Act of 1996, provided an initial identification of environmental resources considered at risk. These resources were identified as soil, water, and related natural resources, including wetlands, grazing lands, and wildlife habitats. However, in conducting this assessment, several additional resources were identified at risk: air quality, cultural and historic resources, and landscape resources.

During the problem formulation stage, data was gathered and used to identify those agricultural practices or activities posing the greatest risk to the environment. These were identified as: crop production; and grazing and livestock production. Conceptual diagrams were developed to hypothesize the cause-and-effect pathways of environmental risk. These pathways are associated with: soil/land disturbances; irrigation water application; pesticide application; nutrient application; brush and noxious weed invasion; pasture grazing; rangeland disturbance; and confined livestock production.

Specific assessment endpoints associated with the resources at risk are: structure of off-site resources and habitats; livestock or plant yields; wetlands functions; viability of aquatic communities; good air quality; survival of threatened and endangered species; extent of natural habitats; quality of cultural resources; potable water supplies; diversity of terrestrial and avian wildlife species; survival of terrestrial and avian wildlife communities; function of riparian areas and wetlands; diversity of natural habitats; diversity of terrestrial communities; and quality of landscape resources. Aquatic communities, threatened and endangered species, wetlands, livestock and plant yields, potable water supplies, air quality, and terrestrial and avian wildlife communities were assessment endpoints common to most hypothesized pathways. This reflects the interconnectivity of agriculture related natural resources.

Cumulative effects, to the extent possible in this report, were also assessed in an effort to provide risk managers with a more complete, in-depth analysis for use on an ecoregion basis. The 10 agricultural production regions of the country were used to represent ecoregions. This choice was made because the States included within each agricultural production region were found to have environmental or ecological similarities. Also, much of the available environmental data used in this assessment is already presented in this format. These "ecoregions" do not, however, coincide with the NRCS regions.

Using this ecoregion approach it was possible to identify specific farm production regions of the country facing significant environmental risks. These risks are due to a combination of factors, including high intensity agriculture, geologic/geographic conditions, and climate acting simultaneously to exacerbate the on-farm and off-site environmental impacts identified in the conceptual diagrams.

Several sources of uncertainty were also identified during the analysis. One is associated with the inter-relation between all the resources of the ecosystem, not just the agricultural community. Time also adds a dimension of uncertainty. Long term on-farm and off-site effects may not be noticed until the resource has been so damaged that the productive capacity is beyond mitigation or restoration. A complete and quantitative environmental risk assessment is difficult to perform for several reasons. The effects of applied resource conservation practices may not be seen immediately. Resource conservation practices done on a single farm, tract, or ranch, may register litter or no effect, from a cumulative standpoint, when assessing a watershed, hydrologic unit, or ecosystem. In addition, there is vast uncertainty associated with the role of agricultural production in landscape scale ecological degradation.

The major conclusion of the risk assessment is that agricultural production activities, if done in the absence of conservation technologies and practices, can, indeed have serious environmental impacts. While agricultural production can produce serious impacts, the introduction, acceptance, and implementation of resource conservation technologies can significantly reduce these threats to the environment.

The team found that the best solutions to address risks to environmentally stressed resources would be conservation measures applied in concerted, concentrated efforts in priority areas with smaller-scale efforts going to sectors outside priority areas. The EQIP should employ a

multiplicity of conservation measures, simultaneously, and on a large scale. The EQIP should address not only onsite problems, but also offsite unintended adverse consequences, as well as cumulative effects. With this "fusillade" conservation approach, remedial actions will have greater effects than could occur with an untargeted approach. Over time, significant ecological improvement should be observed and downward environmental trends will move in positive directions, away from present "at risk" conditions.

The risk assessment also identified the need for additional data to provide risk managers with a more complete analysis of all the environmental hazards related to agricultural production. Better environmental monitoring and evaluation tools need to be designed in order to assemble the actual effects of the application of conservation practices on the environment and on production agriculture. The NRCS currently has the Field Office Computing System (FOCS) available in all field offices. This automated system includes, or is scheduled to include, many needed evaluation tools to provide environmental assessments on a case-by-case basis. The modules that are missing need to be incorporated as soon as possible; NRCS employees can provide appropriate training so that correct usage can be made.

As included in the authorizing legislation, the EQIP is to be evaluated annually to determine the effectiveness of the program, as well as to see if it is achieving the results intended by Congress when the program was created. It is recommended that the evaluation tools used in this analysis contain environmentally significant measurements, including a cumulative effects assessment of the priority area applications.

The results of this assessment demonstrate that natural resources are at risk from agriculturally related activities. Opportunities exist for the EQIP to reduce those risks and to create positive environmental enhancements across the Nation. Where the most severe environmental conditions exist, the EQIP can provide financial incentives and technical/educational assistance to land owners and land users for adopting conservation systems to address those problems.

Given the voluntary nature of the EQIP program, its flexibility, and locally-led approaches, as well as the enormity of the task of changing environmental trends on a national scale, the EQIP cannot address all environmental risk areas at one time. However, where these ecological approaches are employed, substantial environmental improvement can be made. The EQIP as projected to be constituted and with appropriate funding, is capable of supporting remedial actions that can address the environmental and conservation concerns associated with these resources.

If the EQIP follows the priority area approach in applying conservation practices around the country, the program can best function to lessen existing environmental impacts, reduce overall ecosystem stresses, promote ecological harmony, and allow for sustainable agricultural production that is compatible with a quality environment. The cumulative nature of the environmental impacts and improvements would seem to require this more intensive approach, if the intent is to reduce environmental damages to those most sensitive areas and resources.

Included in this risk assessment is an additional analysis of where the EQIP appears to have the most potential for environmental benefit, based on the previously identified hazards and risks. This has been included in the Risk Characterization section of the document. This section is presented to the Risk Managers to assist them in the formulation and implementation of the program.

1. INTRODUCTION

1.1 LEGISLATIVE BACKGROUND

The Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994 requires that a major regulation, one with an annual economic impact of at least $100 million and that affects human health, safety, or the environment, must have a risk assessment conducted. Typically, a risk assessment consists of a technical evaluation of the data characterizing relationships between ecological stressors and resulting adverse impacts on the environment. Uncertainties are identified and stated. The value of the EQIP exceeds the $100 million threshold, so a risk assessment was performed. The following report discusses the results of that assessment.

The EQIP is a voluntary program providing cost sharing, incentive payments, technical assistance and educational assistance to producers for adopting conservation systems designed to protect and improve environmental quality. The EQIP was established in Title III of the Federal Agriculture Improvement and Reform Act, the 1996 Farm Bill. The EQIP is a new conservation program, replacing the functions of four previous conservation programs that existed for a number of years, namely the ACP, the GPCP, the WQIP, and the CRSCP. As of April 4, 1996, the authorities for those programs were repealed.

The EQIP solut.ons will consist of land management or structural practices or a combination of both on eligible lands. These natural resource conservation practices have been proven through years of implementation and evaluation by NRCS and other natural resource agencies, as having the ability to solve simple to complex natural resource problems. Practices to be used must meet the criteria of the local NRCS Field Office Technical Guide and several other technical manuals. Eligible practices will be decided upon by the NRCS State Conservationist in consultation with the State Technical Committee. The process will be guided by a locally led effort of Federal. State, and local agencies, groups and individuals, so that the most significant local problems can be mitigated in the most cost-effective manner.

1.2 EQIP RISK ASSESSMENT

Agricultural land use and the associated environmental impacts are extremely interdependent with very complex chains of cause and effect relationships. Complex feedback mechanisms and buffering characteristics are also inherent in our natural systems. Time lags between land use actions and manifestation of negative effects can be very long and often depend upon the cumulative effects of multiple individual land users. In addition, non-agricultural point and non-point sources of environmental pollutants intermingle with non-point sources from agriculture resulting in an extremely complex human action/environmental consequences linkage. Uncertainty, associated with the influences of weather and market forces and tied to decision-making of agricultural land users, is extremely variable, dynamic, and complex on a national

scale.

The EQIP risk assessment presented here is based on EPA's Framework for Ecological Risk Assessment (1992) and involves three major steps: 1) problem formulation, 2)ecological effects analysis, and 3)risk characterization. The primary purpose of the three-step process is to identify and analyze the environmental stressors and consequences arising from agricultural land uses. This is not a programmatic risk analysis nor an assessment of mitigation efforts supported by EQIP and the expected beneficial environmental effects. EQIP was examined by a separate Environmental Analysis Team and the team developed an Environmental Assessment (EA) with mitigative features. A Finding of No Significant Impacts (FONSI) was developed by the team and is located in this report at Appendix B.

The EPA (1992) definition of ecological risk assessment has been adopted by most government agencies involved with environmental issues and is as follows: ecological risk assessment is "the process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors." A stressor, as used in this assessment, is defined as any physical, chemical, or biological activity or entity that can induce an adverse effect. These definitions for environmental risks and stressors are adopted here with the primary goals of the assessment being to: identify and describe major agricultural ecosystems and related natural-resource concerns; to assess and evaluate adverse ecological effects to agricultural and related ecosystems from agricultural land uses; and to estimate the consequences if nothing is done.

1.3 EQIP ENVIRONMENTAL ASSESSMENT IMPACTS

Good management of natural resources is based on understanding the capabilities and limitations of those natural resources, whether they are associated with land, water, air, plants, or animals. All resources are limited by inherent conditions that must be taken into account when the resource is used. There are no inexhaustible resources on Earth. Additionally, a minimal understanding is that taking or utilizing any part of the resource will have an effect on the resource even though measuring quantitatively that effect or the results of that effect may be difficult or impossible to do.

In every resource equation there are cause and effect (stressor and impact) relationships that are operating usually within a range of acceptable natural responses, at least as far as the resource is concerned. When the use of the resource exceeds the capability of the resource and exceeds this acceptable range of responses, the resource comes under stress ecologically. If the stress is sustained for a long period of time the resource can actually degrade to the point where it cannot sustain itself and the ecological damage may be permanent.

When resource managers do not adequately consider the limitations of the resources with which they are concerned, both the managers and the direct users become part of the complex web of stressors and impacts that may damage the ecological relationships of the resources. The EQIP

offers an opportunity to act as an ecological intermediary to ameliorate possible stressor effects of agricultural activities in this country. As long as EQIP managers are able to adequately assess the potential effects from its implementation, there is the good possibility that soil, water, plant, animal, and air resources will not be stressed to the breaking point and will continue to yield acceptable, if not excellent harvests for human consumption and benefit without damaging or destroying the base natural resources.

2. PROBLEM FORMULATION

The environmental, social, and economic fabric of community that forms our quality of life is dependent upon the relative health or sustainability of the soil, water, air, plants, and animals. The ability to produce food and fiber efficiently and within a healthy ecosystem is essential to current and future generations, both in rural and urban areas. Risks to humans, who live in and are part of the ecosystem, are commensurate with each of the natural resources discussed.

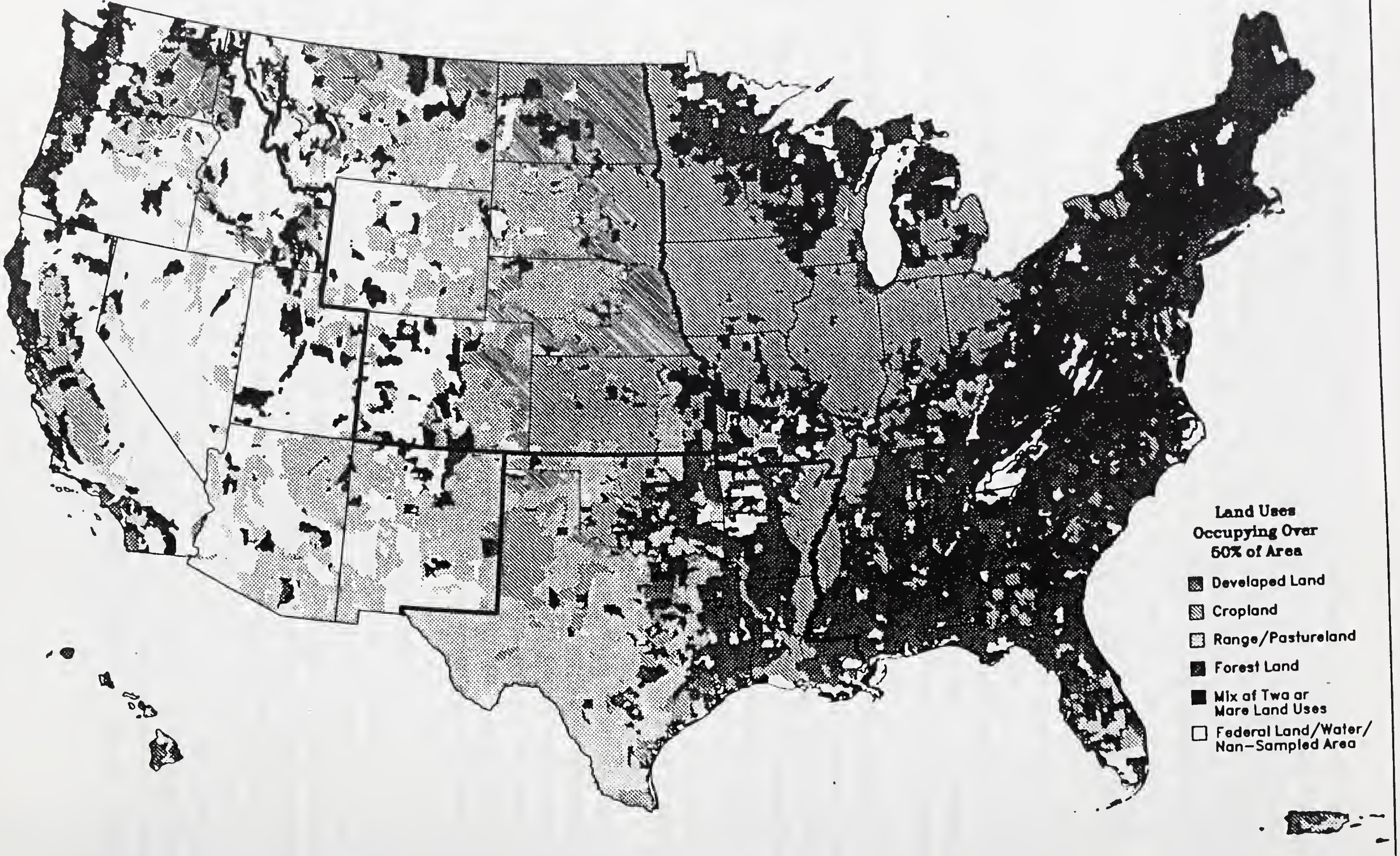
The purpose of problem formulation is to identify the major agricultural land uses and related natural resources of concern, to identify the factors that threaten or stress these systems, and identify the potential adverse ecological consequences of identified stressors. In 1994, NRCS held Regional Reinvention Forums to identify the thoughts and ideas of local participants. From the NRCS Reinvention Forums' Survey the top five natural resource issues were shown primarily to be centered around water quality was the major concern in five of six regions. Soil erosion was the second most important concern in four of six regions. Agricultural sustainability was ranked second or third in four of the six regions.

The major agricultural land uses, along with the major agricultural practices have been examined by an interdisciplinary team of NRCS experts, who were selected for their experience and competence in evaluating environmental conditions. From these land uses and practices, the expert team developed the most probable impacts and effects that could be expected to occur. These "risk scenarios" or hypotheses are highlighted in the form of conceptual diagrams, that reflect those resources listed as being most at risk.

Map 2.a shows the Dominant Land Uses as of 1992, across the Lower 48, Hawaii, Puerto Rico, and the Virgin Islands. Not all land uses are shown on the map, but many of the major types, that are covered in this report, are represented on the map and many of the land uses where environmental impacts could occur are also represented on the map. Alaska has not been included on this or the majority of the other maps included in this report, not because of any absence of resources perceived as being at risk, but due to the vast size and diversity of the area.

Cropland (421 million acres) is heavily represented in the central part of the country spreading from Pennsylvania and Ohio across to Nebraska, Kansas, and southward to Texas. From the North in the Dakotas and Montana, cropland extends southward through the Mississippi River Valley to the Gulf of Mexico. Other regional areas of cropland are the Palouse of Eastern

Dominant Land Uses, 1992



Map ID: RWH.1542

Source: National Resources Inventory, 1992

Washington and Oregon, the Central Valley of California, the Mid-Atlantic region and the Southeast.

Pastureland and rangeland (126 million acres, and 399 million acres respectively) is well-represented all across the United States with pastureland predominating in the East southward to the Gulf States and rangeland the dominant type in the West, especially concentrated from Montana and the Dakotas through Wyoming and Nebraska to Texas, Arizona and New Mexico. Rangeland areas of regional consequence are Florida, California, Washington, and Oregon.

Forestland (395 million acres) constitutes major land uses in both the East and Western regions of the Nation. These areas are located especially along the Appalachian Mountain Chain into the Gulf States, and Northwestern area. In the West, much of the Federal lands are in forestland vegetation, such as national forests and national parks. The Upper Midwest, Michigan, Wisconsin and Minnesota have extensive forestlands, while coastal California, Oregon, and Washington have additional acreages.

"Other rural lands" (50 million acres) are those used for agricultural purposes after the major agricultural land uses (cropland, pasture/hayland, rangeland and forestland) are counted. Concerning landscape resources, the 1992 National Resources Inventory (NRI) includes farmsteads and other farm structures, field windbreaks, marshland and barren land, such as salt flats or exposed rock. The NRI also includes all land under contract in the Conservation Reserve Program (CRP) as of 1992, which is approximately 39 million acres. For the purposes of this assessment, CRP land is included with cropland for evaluation purposes and is reflected in the total acreage (421 million acres).

2.1 NATURAL RESOURCES AT RISK

Public Law 104-127, in creating EQIP, provided an initial identification of natural resources considered as being at risk. These are: soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat. These natural resources are considered as being environmentally at risk as a result of agriculturally related practices and activities. The focus of the following sections concentrates on the resources considered as being at risk, and examines the consequences of risk-producing practices and activities.

There are many human activities occurring on the landscape that can create stressors to the Earth's natural resources. Some of these activities as they relate to agriculture include the application of animal waste to the land, cropping practices, and the application of irrigation water. These stressors cause effects, such as accelerated soil erosion, increased soil compaction, reduced soil tilth, contaminated surface and groundwaters, increased sedimentation, and reduced air quality.

2.1.1 SOIL RESOURCES

Soil quality and erosion problems can decrease agricultural productivity dramatically. Offsite sedimentation results in impaired watercourses or water bodies and repeated drainage and cleanout maintenance and costs. Unrestricted land use conversion increases runoff problems and loss of prime farmland soils. Frequently, sediments carry fertilizer and pesticide particles that can impair drinking water, recreational uses, and the wetlands that sustain the food chain of active and vital ecosystems.

Erosion is a function of both changing and unchanging factors. Changing factors consist primarily of a farmer's use of the land and the land management practices. Relatively stable or unchanging features which effect erosion rates are physical parameters, including geology, hydrology, rainfall, soil texture, and topography. Sheet and rill erosion, gully erosion, and scour erosion are natural processes, but have been greatly accelerated as a result of human activities. Erosion in many regions of the country has reduced on-farm soil productivity and contributed to offsite water-quality problems.

Soil quality is determined by a set of many highly correlated physical, chemical, and biological properties, such as soil depth, water-holding capacity, bulk density, nutrient availability, organic matter, microbial biomass, carbon and nitrogen content, solid structure, water infiltration, and crop yield. The change in soil quality is a function of factors including, climate, hydrogeology, cropping and other cultural practices. Soil quality degradation occurs through physical, chemical and/or biological processes.

The amount of organic matter and clay particles determines the sorptive capacity of soils. Biological degradation of the soil (or loss of organic matter) causes significant adverse effects on the physical and chemical properties of the soil. Biological degradation may be a consequence of production agriculture, if proper conservation practices are not instituted with production.

A soil's infiltration rate and its ability to adsorb pollutants depends in part on its physical, chemical, and biological characteristics. Also, prior soil moisture content markedly affects the amount of water that can infiltrate. The infiltration rate affects the ratio of surface flow to subsurface flow. With an increase in the infiltration rate, the pollutant load associated with surface runoff would decrease.

Sandy soils generally have high infiltration rates and low water-holding capacity because of large soil particles and relatively large pores through which water can percolate. Because the total (particle) surface area and the total negative charge of sandy soils are less, their adsorptive capacity is generally much less than that of clay soils. Soils that are both well drained and contain sufficient amounts of clay and organic matter, will adsorb the most pollutants.

Subsoil characteristics may either retard or enhance internal drainage and influence the proportion of surface and subsurface flow. Natural barriers, such as claypans or fragipans.

reduce the downward movement of water through the soil. All of these factors affect the quantity and rate of pollutant delivery to groundwater.

Compaction is major physical process that can also degrade soil quality. Soil compaction from heavy machinery and mismanaged livestock grazing degrades soil quality by impeding seedling emergence and decreasing water infiltration. This creates offsite problems resulting from higher surface runoff of rainwater and increased water-related erosion.

2.1.2 SURFACE AND GROUNDWATER RESOURCES

Potential surface and groundwater quantity and quality problems arise from both natural and human activities. The impact of human activities, including agriculture, recreation, transportation, resource extraction, and industrialization, have greatly accelerated the deterioration of the Nation's water resources. There have been a significant number of Federal, State and local government law and programs, as well as private initiatives developed to enhance water quality and quantity. While the national goal of "fishable and swimmable" waters has not been attained in many areas, there are, however, many success stories documenting water-quality improvement and restoration of ecosystem integrity.

Data on water quality is incomplete regarding the spectrum of contaminants released into the environment and their cumulative impacts. Only a small fraction of the Nation's water impoundments and stream and river miles have had consistent monitoring programs developed for data collection and analysis. This data set is even less substantial for the assessment of the quality and quantity of the Nation's ground water. Because of the lack of data, there are conflicting assessments of how successful water-quality programs have been.

Various reports still identify many sources of pollution and activities affecting the Nation's surface and ground water supplies. Siltation, nutrients, organic matter, and hazardous materials are some of the contaminants affecting surface water. Groundwater supplies are impacted by failing septic tanks and agricultural sources, such as animal wastes, fertilizers, and pesticides. The destruction of wetlands, that serve to protect the quality of surface and groundwaters, has been slowed, but wetland losses are still high.

Soil erosion and resulting sedimentation is the major cause of nonpoint source pollution that threatens water resources. While the outright effects of land scouring and gully erosion can be more dramatic in its appearance to the public than sheet and rill erosion, the latter form of erosion contributes large quantities of sediment to the Nation's waterways and water bodies. The amount of deposited sediment in a stream can affect channel shape, sinuosity and the relative ratio between riffles and pools. Excessive sediment in a stream causes a decrease in channel capacity that in turn results in more frequent and larger floods. In addition to the adverse physical effects of sediment loads, many nutrients, pesticides and heavy metals are sorbed onto fine sediment particles that may result in eutrophic or toxic waters. Indirect effects of increased

sediment loads may include increased stream temperatures and decreased intergravel dissolved oxygen levels.

On-farm applications of fertilizers directly contribute to the degradation of surface- and groundwater quality because of adverse cumulative effects and, in some cases, due to excessive applications. The hypoxic zone in the Gulf of Mexico may be a direct result of this effect. Currently, this zone, which during the summer months cannot support normal fish and shellfish populations due to a lack of oxygen, covers more than 6,000 square miles near where the Mississippi and Atchafalaya Rivers flow into the Gulf of Mexico. The zone not only represents an environmental problem, but also represents a very real economic problem to the marine fishery industry along the Gulf. Links to nutrient loading thousands of miles upstream have not been proven, however, runoff from farmland is considered as being the main causal source of this problem, with approximately 31 percent of the nitrogen flux to the gulf of Mexico contributed from the Upper Mississippi Basin. (Source: "America's Private Land, A Geography of Hope," USDA-NRCS, 1997.)

Pesticides, which include insecticides, herbicides, fungicides, miticides, nematicides, and algaecides, are used extensively in agriculture to control pests and enhance production. About 75 percent of all pesticide expenditures in the United States are for agricultural purposes. Seventy percent of these are for herbicides, particularly for use on corn.

Pesticides are lost from an agricultural operations through volatilization, chemical, and biological degradation, leaching, and by removal in runoff, either in solution or on sediments. Volatilization and leaching of pesticides are the primary methods of impact on farmsteads. When pesticides are not properly handled, runoff can deliver pesticides to surface waters and to groundwater.

Susceptibility to both fertilizer and pesticide sources of environmental risks is greatly enhanced in areas with karst terrain. Agricultural producers have made efforts to use fertilizers and pesticides in a more effective and environmentally sensitive manner. Integrated pest and fertilizer management, and more currently, computer enhanced application methods are being used by more and more farmers and ranchers, but there is still considerable need for improvement in the timing and application of both fertilizers and pesticides.

It is reasonable to conclude from the limited monitoring and assessments conducted on groundwater supplies that the shallowest aquifers are at greatest risk for contamination from human activities. Presently, deep aquifers are believed to be relatively free from contamination. However, an EPA survey shows that about 20 percent of all drinking water aquifers are contaminated to some degree by chemicals.

Irrigation-induced environmental problems due to increased levels of salt, expressed as salinity, is a form of chemical soil pollution that can lead to significant crop yield reductions. Increased levels of salt in water supplies can be toxic to domestic crops and livestock, as well as terrestrial and avian wildlife species. Of the irrigated acreage in the Nation, approximately one-fourth (10 million acres) exhibits salt-induced water quality and yield reduction problems. The most severe

salt problems occur in the arid and semi-arid West. More than 90 percent of the total irrigated land in the United States is located in eight major river basins of the West, encompassing parts of 17 States. Major salt-related water-quality problems have been identified in seven of those eight basins.

2.1.3 GRAZING LAND

The United States has about 770 million acres of grazing lands, including pasturelands and rangelands. These range from the wet grasslands of Florida to the desert shrub ecosystems of Wyoming to the high mountain meadows of Utah to the desert floor of California. Rangeland is land where the native vegetation is predominately grasses, grass-like plants, forbs, or shrubs and that is used by animals for grazing or browsing. In their entirety rangelands include natural grasslands, savannas, deserts, tundra, alpine plant communities, coastal marshes, wet meadows, and introduced plant communities that are managed like rangeland. Pasturelands are, for the most part, located in the more humid areas of the midwest and eastern U.S., and are commonly composed of both native and introduced grass and forb species. Pasturelands can be located in all topographical locations, but for the most part, are usually located where crop production is not possible or desirable due soil, topographic, or other limitations.

Overgrazing exposes land to excessive erosion and soil compaction. Soil compaction results in excessive runoff and reduced plant growth. Management of livestock, specifically the impacts of grazing and hoof action, is a stressor that producers can control. The numbers, type, distribution of livestock, frequency of grazing, season of use, and the amount and type of plants harvested by the animals are factors or stressors that affect rangeland and pastureland environmental responses.

Grazing animals can change the vegetation mix significantly by concentrating on certain species and preventing the favored species from surviving. Grazing may also favor the development of denser stands, more intrusion by fire-intolerant species, and forest conditions that result in plant stress, epidemic pest outbreaks, and large intense stand-replacing wildfires. Alien or invader species establish more easily in overgrazed areas.

Noxious weeds have been introduced to many rangeland communities. Without active campaigns to control their spread, weeds, because of their aggressive nature can greatly reduce the diversity and value of rangeland communities. Dominance of a site by a single, undesirable species, reduces the ability of that particular area to provide habitat for wildlife and suitable grazing land livestock. The plant community has decreased ability to respond to stressors as fewer plant species are available. With fewer plants available, groundcover is reduced, subjecting the soil resources to the effects of erosion from wind or water. The resulting sediment and silt can then provide surface water pollutants, as previously discussed. Groundwater can also potentially be reduced as invading plant species mine groundwater, reducing aquifer recharge and streamflow.

2.1.4 WETLAND RESOURCES

Wetlands are valuable natural resources, providing improved water quality, flood and storm protection, important fish and wildlife habitats, and opportunities for hunting, fishing, boating, bird-watching, and other recreation. Wetlands are vital and dynamic ecosystems that can be covered by or saturated with water for either part of the growing season or the entire year.

The major types of wetlands that occur naturally are swamps, floodplain forests, bogs, and tidal or freshwater marshes. Tidal and freshwater marshes are characterized by herbaceous plants, and ponded water that varies in depth seasonally. Some marshes, such as coastal marine wetlands, may be flooded all year. Other types, such as prairie potholes, may be completely dry for much of the year. During dry years, some prairie potholes are farmed. Swamps and floodplain forests are dominated by trees, shrubs, and other woody plants, that are adapted to flooding, ponds, or saturated soil conditions. Swamps and floodplain forests are particularly prevalent in the Southeastern U.S. Bogs are typically found in formerly glaciated parts of the Northeast and the Appalachian Mountains. They are characterized by a peaty substrate, evergreen trees, shrubs, and sphagnum moss.

From 1954 to 1974 an average of 398,000 acres of wetlands were lost annually due to landuse conversions, mainly from drainage for agricultural production. From 1974 to 1983, an average annual loss of 157,000 acres of wetlands occurred. And from 1982 to 1992 an estimated 31,000 acres of wetlands were lost every year (Source: USDA Soil Conservation Service, 1992 National Resources Inventory).

Drainage of wetlands stresses the environment by reducing critical water regimes that support threatened and endangered species habitats. Areas of wetlands that have been drained in past years has been substantial with more than 53 percent of original wetland acreages affected. Draining wetlands reduces the capacity of the environment to "clean" water through filtration of waterborne sediments, chemicals and nutrients and the beneficial actions of microbially mediated bio-transformations as water passes through wetland areas. Wetland-supported vegetation absorbs and assimilates many of the excess nutrients, pesticides, and other wastes from agricultural production, potentially filtering the water for reuse. The disappearance of these wetland filtration systems effectively causes more pollutants to enter both surface- and groundwater supplies. The overall results of this are increased costs for water filtration and purification.

Traditionally, palustrine wetlands have been called marshes, swamps, bogs, fens, and prairie potholes. Palustrine wetlands include all nontidal wetlands, that are dominated by trees, shrubs, persistent emergent vegetation, emergent mosses or lichens, plus all wetlands that occur in tidal areas where salinity from ocean-derived salts is below 0.5 parts per thousand.

Agricultural lands that come within 100 feet of water or wetlands may have the greatest chance to negatively impact those waters and wetlands. A prime consideration for agricultural interests is how to keep excessive amounts of sediment from entering wetlands. While wetlands can

assimilate large quantities of silt and sediment over time, wetlands can be overwhelmed by sudden influxes of sediment, that can either impair the wetland's functioning or obliterate it in a worst-case scenario.

As a grouping, wetlands constitute the most sensitive of habitats when it comes to environmental stressors. While wetlands have large capacities to absorb environmental impacts, once the capacity is exceeded there is little chance for unassisted "recovery," to the original condition of the wetland. For the most part, damaged ecological processes within wetlands are not reversible. Instead what often happens is that a wetland reaches a new equilibrium. Whether or not that new equilibrium is capable of being sustained over a long period of time is a separate question and one that a natural resource manager must ask every time he or she finds a wetland becoming part of the total natural resource planning scope.

A wetland has certain bio/geologic capabilities to accept sediment loads, while still maintaining all of the integrated functions to support and nourish living systems dependant upon the wetland for food, shelter, and reproduction. In a well-functioning wetland, nominal inputs of sediment do not adversely affect functioning wetlands.

Part of the reason that a wetland can accept nominal amounts of sediment without wetland change is that small amounts of sediment cover over living plants and animals on the bottom of the wetland. While sediment can cause the benthic organisms to smother and die, the sediments also complete the covering process causing already dead organisms to decay at even lower elevations. As this decay occurs, the sediment that had been added on top of the wetland begins to sink from the raised level back toward the original level of the wetland. In this way, the wetland maintains a relatively constant level over time even though sediment is constantly entering a wetland and becoming entrained in the wetland.

A wetland can become threatened by sediment when large volumes enter a wetland in very short periods of time. Then the natural bio/geologic processes are short-circuited and natural processes cannot work. The wetland becomes degraded or may become completely nonfunctional. The objective of the EQIP in a priority area must be to control and prevent excess sediments from entering watercourses where they could be carried to wetlands. NRCS conservation practices must be instituted on farms, ranches, and in urban and suburban areas to prevent sediments from leaving those places and to protect receiving waters and wetlands from getting excess sediments if they get entrained in the water.

Wetlands take on additional meaning when considered in the context of threatened and endangered species. As many as two-thirds of the plants and animals that are on the Federal or State threatened and endangered species lists have some part of their life cycle associated with wetlands, either for food, shelter, reproduction, or other functions. So impacts that adversely affect wetlands, also adversely affect threatened and endangered species. Less food produced by the wetland means less food for the threatened and endangered species in the wetland. Dead and dying plants, leaving bare areas, mean fewer nesting sites for birds. Conversely, overcrowding by overgrowth of a single plant species in degraded wetlands can mean abundant vegetative

growth, too thick for animals to penetrate and utilize the area, reducing the wetland's available resources for the threatened and endangered species.

2.1.5 WILDLIFE RESOURCES

The following stressors, including accelerated sedimentation to streams, wetlands, and riparian zones, excessive application of fertilizers, pesticides and other chemicals, alteration of wetlands, desertification, and conversion of woodland and riparian zones to cropland have had major impacts on wildlife habitats, wildlife species, and population dynamics.

Wildlife habitats constitute a variety of ecosystems from urban to rural to agricultural to wilderness, but all have several aspects in common, mainly that the habitats must be able to sustain the shelter, and the nutritional and reproductive needs of the animal species in those habitats. Additionally, since organisms are adapted to specific habitats, a diversity of habitat types will support more kinds of organisms and enhance overall biodiversity.

Wildlife habitats are highly diversified in their geographic extent. They include the soil, water, and air as elements in their composition and geographically may be wide, narrow, long, short, deep, or high or a combination of these. Endemic and migratory animal species are impacted from human activities and stressors.

Human stressors on wildlife populations, putting them at risk or creating threatened or endangered species, are overexploitation, overprotection, or neglect. As with plant species, native animal species have been adversely affected by the introduction, either intentionally or accidentally of non-native species. Competition for food and habitat, disease, and predation on other animal species are concerns borne from the introduction of these non-native animal and plant species.

2.1.6 ANIMAL RESOURCES

Another significant concern with grazing lands is the improper management of grazing animals. Some grazing practices, including some hog production facilities, allow animals free access to creeks and streams. This access is provided primarily for water availability and consumption. In this practice, creek and stream banks are eroded, resulting in additional sediment added to the water source. Also, with the unlimited access, animals can be found loafing or resting in the water area, allowing for contamination with animal waste products.

Not including nutrient losses to the environment that occur during manure collection and handling, or the manure excreted by grazing animals, manure applied to cropland in 1992 contained an estimated 2.2 million tons of organic nitrogen and 1.6 million tons of phosphorus. Cattle and calves and dairy animals together produced two-thirds of these nutrients. Broiler chickens produced about one-fourth of the nitrogen and market hogs, a similar share of the phosphorus.

If done improperly, waste and nutrient applications result in: chemical and nutrient imbalances in air, water, and soil; bacteria and pathogen contamination of soil, water, and air; organic matter loading in water bodies; runoff and erosion; and unwanted odor. As more and more animal production is concentrated into more intensive management units, adequate area for disposal of wastes becomes an important consideration. Often, pasturelands, and to certain extents, cropland, become dumping grounds with excessive manure application rates. From a water quality perspective, some nutrient losses into water will occur whether the application rates exceed crop and soil assimilative capacities or not.

Runoff from confined animal facilities may result in fecal contamination of surface and groundwaters. Proximity of livestock confinement structures and storage/treatment facilities to wells on farmsteads makes local ground water sources particularly vulnerable to contamination. Runoff from livestock facilities also results in surface water impairment. Concentration of pathogens in water where humans swim or where shellfish are harvested presents a significant risk of infection. One of the major sources of pathogens is runoff from feedlots.

2.1.7 OTHER RELATED RESOURCES

2.1.7.1 AIR RESOURCES

Air quality is a serious environmental concern in the United States. Agricultural sources adversely affecting air quality include tillage practices and large confined livestock operations, that include feedlots, hog parlors, and poultry houses. Stressors from these operations on human health are wind-blown dust particles and odors. Particulate matter less than 10 micrometers in size (PM-10) are nearly invisible dust particles that can stay windborne for long periods of time and transported great distances. These dust particles create health problems, especially for people with respiratory problems.

Agricultural tillage is a major source of fugitive dust in specific regions of the country, such as the Great Lakes, Upper Midwest, Pacific Northwest and the Great Plains. Upwards of 50 percent of the contaminants entering the Chesapeake Bay are airborne and have come from outside the Chesapeake Bay watershed and airshed. More specifically, computer model calculations indicate that roughly 75 percent of nitrogen deposition from the air that lands inside the Bay watershed is from sources outside of the watershed. These sources of air pollution, both agriculturally and non-agriculturally related, may occur hundreds of miles from the Bay watershed (Source: Blankenship, 1995).

Other agricultural practices contributing to airborne contaminants include forest clearing by fire and crop residue burning. These practices contribute to the generation of carbon dioxide and carbon monoxide and also leave the soil vulnerable to wind erosion. These effects result in undesirable and unhealthy living conditions, as well as contributing to the world's "greenhouse" effect.

Certain practices can be applied to the landscape to aid in reducing airborne dust particles and odors from agricultural sources. Windbreaks, wind fences, vegetative barriers, and cover crops are some of the practices that can reduce wind speed and the potential for wind-blown dust particles. Also, conservation tillage is effective in eliminating exposed soil particles to wind action. Properly constructed animal waste systems and effectively employed management plans can greatly reduce and/or eliminate odors from livestock operations.

Historically, the singular air quality issue associated with livestock production is odors. Present environmental concerns focus on odors, but also include ammonia and methane emissions as well. Ammonia volatilization can contribute to elevated nitrogen in precipitation, that can lead to excess nitrogen in water bodies and the acidification of soils. Methane has been identified as one of the primary contributors to the group of greenhouse gases linked to global climate change. Animals, such as swine and cattle account for a significant percentage of methane emissions associated with manure production.

Odors can arise from many agriculturally related activities. Odors may emanate from areas with large animal concentrations having minimally constructed or no animal waste facilities and/or improperly managed animal waste systems, including storage, removal, and application of animal wastes and composting and disposal of dead carcasses and litter. Other sources of odors may occur from operations, such as vegetable and meat processing plants.

As urban and suburban areas grow closer to rural agricultural areas, the issue of odors has come to the forefront in many communities. Many former urban and suburban residents have come into conflict with agricultural interests because of odors produced by active agricultural operations. Many of these residents fear that their homes and property will be devalued because of poor air quality. Usually, it has been found that when both groups work together, agricultural operations can continue, and objectionable odors can be reduced.

2.1.7.2 CULTURAL AND HISTORIC RESOURCES

In the broadest sense, cultural resources are the traces of human activity throughout time. They include archeological sites, buildings, structures, objects, and less tangible aspects of landscapes, folklife, and traditional cultural practices. This assessment is primarily concerned with historic properties, the physical deposits, structures, and archeological sites of significance that contain the material evidence of past cultures and environment that is at risk.

A great number of our Nation's historic properties are located on private lands, but are afforded little protection unless the activities are conducted on these lands with Federal involvement, as detailed in the National Historic Preservation Act. The significance of historic properties is inextricably linked to site integrity and the presence of intact surface structures and subsoil cultural deposits, that are adversely affected by the same stressors that degrade soil quality.

Unlike soil, which can often be improved, historic properties are nonrenewable, and once degraded, result in a loss of important environmental information and heritage values.

Of the known archeological sites recorded by State Historic Preservation Officers (SHPOs), approximately 45 percent or over 418,000 of these are on private lands. Cropland uses account for 125,000 of these identified sites with approximately 22,770 of these impacted by irrigation and the rest affected by row crop or other agricultural practices.

There is a direct physical relationship between archeological sites and erosion, i.e., since material remains are part of the soil medium, erosion affects them with absolute finality by reducing or completely removing their physical integrity and informational context. Thus, when cultural sites are unmanaged, and improperly applied practices degrade soil quality, there are cumulative adverse effects on the integrity of nonrenewable cultural resources. Land management practices applied to cropland, involving soil displacement, have direct adverse impacts, unless they can be mitigated, either to save, conserve, or extract important cultural information first.

2.1.7.3 LANDSCAPE RESOURCES

Landscape resources are those relating to the visual aspects of agricultural production and how that production influences the landscape. Landscape resources include all aspects of production from farmsteads and associated buildings/structures to fields and geologic formations to the placement of fences and windbreaks.

Farmsteads and farm structures include livestock production facilities and associated waste storage or treatment facilities for dead animal disposal, pesticide storage/handling facilities, and soil amendment (primarily commercial fertilizers) storage and handling facilities. Primary impacts of these facilities are degradation of air and water quality through varied, but complex processes. Secondary impacts of associated waste storage and treatment facilities are on the farmstead itself, including the aesthetic qualities and character as well as the historic properties often associated with older, multigenerational farm operations.

Sensitive geologic formations affect the transport and delivery of pollutants to ground- water. One of the most frequently occurring landforms that has a major impact on this is karst topography. Fifteen percent of the land mass of the continental United States, excluding Alaska, is classified as karst. Puerto Rico is significantly affected by karst topography. Important avenues for groundwater pollution in karst areas are sinkholes, which are openings that develop where surface deposits are shallow over limestone bedrock. Sinkholes form when water moves through soil into fractures in the bedrock and dissolves the limestone, leaving voids below the surface. Over time, the voids enlarge, and collapses can occur. Unfiltered water can enter the collapsed areas and groundwater system. The result is that activities on land can harm groundwater quality in aquifers that serve as sources of water for rural and municipal wells.

Activities that can harm groundwater through sinkholes vary. Sinkholes have been used for disposal of hazardous materials, such as chemical residues in pesticide containers and other chemicals used on the farm. In some cases, they have even been used for disposal of dead animals. Sinkholes provide a direct pathway for pollutants, such as runoff from feedlots to reach the groundwater.

A survey of farmers' perceptions and attitudes toward sinkholes was conducted by Gary Huber, water quality specialist, Iowa Natural Heritage Foundation, in 1990. A copy of his paper, "Landowner Perceptions of Sinkholes and Groundwater Contamination," was published in the March-April 1990 edition of the Journal of Soil and Water Conservation, Vol 45, No. 2. His conclusion was as follows:

> "Owner/operators of land with sinkholes acknowledged several possible sources of groundwater pollution through sinkholes, including some not generally recognized by the public, such as feedlot runoff into sinkholes. Most thought sinkholes were a threat to safe drinking water, and most felt runoff from agricultural land into sinkholes was why they were a threat. Many farmers were taking steps to address runoff into sinkholes; they were most receptive to additional options that would not disrupt their farm operations. Most were concerned about runoff into sinkholes, and it appeared that significant changes to address pollution through sinkholes will not be made without government involvement. They felt appropriate cost-share assistance for practices to control runoff into sinkholes needed to be slightly higher than levels normally provided to encourage adoption of these practices."

2.2 EFFECTS AND IMPACTS FROM AGRICULTURALLY RELATED PRACTICES AND ACTIVITIES

This section presents a short discussion on the agriculture practices and activities that could adversely affect natural and other resources that previously discussed. The emphasis will be on the effects and impacts of agricultural production, primarily from the production of commodity crops and livestock.

2.2.1 CROP PRODUCTION

For the purpose of this assessment cropland is defined as follows: Land that is irrigated, nonirrigated, cultivated or noncultivated, with the specific purpose of producing an agricultural commodity, and also land which can include CRP acreages. Based on the 1992 NRI, there are currently 421 million acres of cropland in the United States, making up 28 percent of the non-Federal land area.

Cropland acts ecologically between a greenhouse and natural lands. Therefore, cropland can never be completely divorced from its "natural" heritage and must accommodate the surrounding environments, as well as considering how to get a productive yield. Sediment, nutrients, animal

wastes, pesticides, and salts must not only be considerations for the fields in which crops are grown, but also these elements must be considered for the impacts they will have on adjacent environments.

The continued sustainability and productivity of cropland resources are of great importance if our Nation is to have a reliable and economical food supply in the United States for present and future generations. The three top-ranked concerns for natural resources are: water quality, soil erosion, and agricultural sustainability. Continued exposure of these resources to the forces of wind and water without a high degree of management can result in onsite degradation, as well as offsite damages to other resources, including soil, water, plants, animals, air, and humans.

The major activities employed to produce crops are tillage operations, irrigation water application, fertilizer application, including animal waste application, and pesticide application. These activities can induce stresses on resources that directly or indirectly affect overall environmental integrity.

Cropland uses can be broken down as:

1. Cultivated cropland - 325.3 million acres, (47.6 million acres irrigated and 277.7 million nonirrigated acres);
2. Noncultivated cropland - 56.9 million acres, (14.5 million irrigated acres and 42.4 million acres nonirrigated).

Tillage is any operation by humans to open the soil and plant a seed with the intent of harvesting a crop. Over human history, tillage has been accomplished in many ways, but always the objective has been to enhance human survival by being able to harvest a crop at a future time.

Any tillage and planting system that leaves all or some portion of the previous crops' residue on the soil surface is termed "crop residue management". The quality of soil, and its capacity to perform beneficial functions relative to particular land uses, can be directly impacted by the types of activities performed, with major reductions in soil quality due to excessive soil erosion. Surface cover greatly reduces soil erosion, even though the percentage required to adequately control erosion depends on the site and other conservation practices included in a total erosion-control system. As residue cover approaches 100 percent, soil erosion approaches zero. However, with 50 percent residue cover, erosion is reduced by approximately 83 percent, while with 10 percent residue cover, erosion reduction is still about 30 percent.

2.2.2 GRAZING AND LIVESTOCK PRODUCTION

Pasturelands and haylands account for about 8.5 percent of total land or 126 million acres nation wide, while rangelands account for approximately 698 million acres. Activities or natural factors (stressors) that contribute to or constitute the adverse ecological effects of soil, and water degradation can be shown in two broad categories. These categories are management activities

and natural factors. The primary management activity is the grazing of livestock. Natural factors include weather, pests, fire, and other impacts brought on by nature.

Fourty-six percent of the grazing lands are in need of some form of conservation treatment. When treatment is considered, improved grazing management is needed on about 28 percent of the area. The remaining 18 percent needs treatment such as erosion control, drainage or irrigation management, weed control, and forage re-establishment.

Fifty-seven percent of the Nation's rangeland (or 398 million acres) is privately owned and is concentrated, for the most part, in the western United States. Rangeland is defined by USDA as land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs suitable for grazing or browsing use. Rangelands include natural grasslands, savannas, most deserts, tundra, alpine plant communities, coastal marshes, wet meadows, and introduced plant communities managed like rangeland.

The majority of private rangelands are utilized to various degrees in the commercial production of livestock, cattle, goats, sheep, horses, reindeer, and exotic species. Recreational (hunting, nature tours, and so forth) opportunities are also increasing the demands that man is placing on this renewable natural resource.

2.3 ECOLOGICAL CONCEPTUAL DIAGRAMS

These diagrams represent the risk hypotheses beginning with the identified agricultural activities that potentially stress the environment through the cause and effect pathways of ecological impacts for the primary agricultural practices of crop production, livestock grazing and livestock production. The conceptual diagrams delineate ecological pathways consisting of: risk initiators; system stressors; ecological effects; and assessment endpoints.

The conceptual diagrams were developed by the Risk Assessment Team to better visualize how ecological stressors and impacts developed concerning particular resources and how an impact in one instance became the stressor for another impact in the same pathway or in starting another pathway of stressors and impacts. These cause/effect relationships allowed the team members to trace resources from an unimpacted state through a state of ecological stress to environmental effects (endpoints) where the original resource at a minimum is compromised in its ability to be a viable resource, but at a maximum that the resource may become non-functional from an ecological standpoint.

The following conceptual diagrams have been developed: soil and land disturbance; irrigation water application; pesticide application; nutrient and animal waste application; brush and noxious weed invasion; pasture grazing; rangeland grazing; and confined livestock production. Pasture and rangeland grazing have been presented in separate conceptual diagrams due to the difference in both management and conservation treatment needs of these two land uses. Where

information about a certain pathway is included in another conceptual diagram ecological discussion, the specific reference is cited on the diagram.

2.3.1 SOIL AND LAND DISTURBANCE

Soil or land disturbance can occur as a result of many human activities and may be aggravated by natural forces, such as wind, rain, and drought. In an agricultural setting, soil and land disturbances occur through activities such as plowing, planting or managing livestock. The effects can be short- or long-term and affect the immediate or an offsite area.

Soil erosion and compaction are likely the most extensive forms of soil disturbances encountered when examining the effects to and from the agricultural systems being examined in this assessment.

2.3.1.1 ECOLOGICAL PORTRAIT

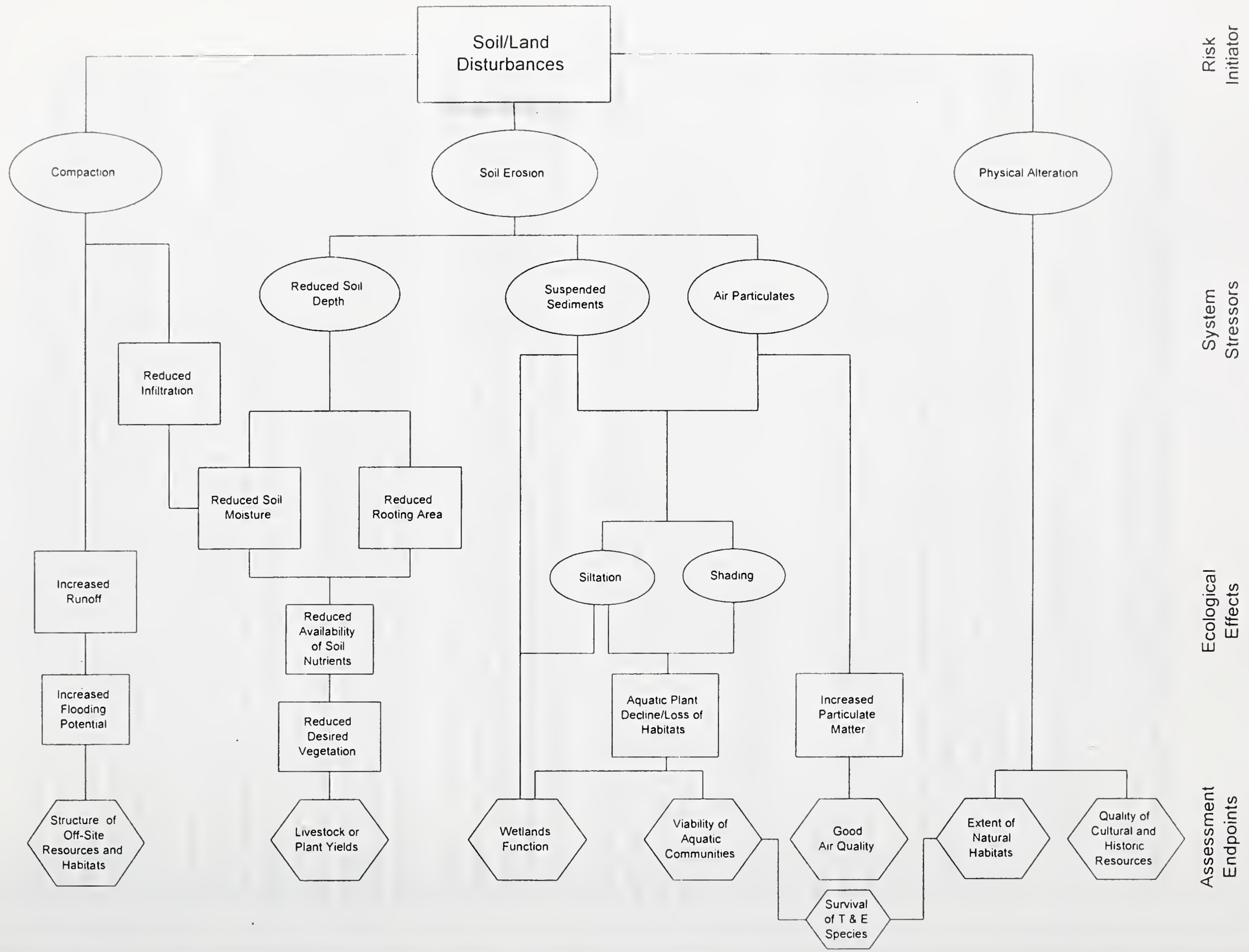
Specific resources that have been shown to be at risk in this assessment from soil/land disturbances are wetlands, aquatic communities, threatened and endangered species, and cultural and historic resources. Potential impacts to these resources must be accurately and carefully documented as part of the planning process for EQIP implementation.

Land disturbances have both short-term and long-term implications for assessment endpoints. In the short-term, land disturbances whether tillage, construction, or other practices, increase the amount of particulate matter in the air, especially PM-10. These small particles add to air quality problems and in some parts of the country, such as California's Central Valley, can cause significant deterioration of the air.

In the long-term, physical alteration of the land can lead to disturbance of cultural resources, especially from construction activities, and can have devastating consequences for any cultural or historic resources involved. Usually, the consequences of land disturbance cannot be reversed with an ultimate loss to the culture and history of society at large.

Soil/land disturbances can have profound ecological effects on livestock or plant yields. Soil compaction and soil erosion are the natural resource issues upon which NRCS has been providing technical assistance for the past 60 years. It is an ongoing battle to control these processes to keep agricultural lands productive within the ecosystem as a whole.

When soil becomes compacted, aeration of the soil to promote plant growth is inhibited and the soil becomes a hard surface that runoff waters can easily speed over, leaving the land drier with receiving waters getting many of the nutrients that were intended for cultivated crops. As a result the land gets less of what it needs to produce good crops, and receiving waters get more of what they don't need, mainly nutrients that promote excessive aquatic plant growth.


Soil/Land Disturbances
Compaction
Soil Erosion
Physical Alteration
Reduced Soil Depth
Suspended Sediments
Air Particulates
Reduced Infiltration
Reduced Soil Moisture
Reduced Rooting Area
Increased Runoff
Siltation
Shading
Reduced Availability of Soil Nutrients
Increased Flooding Potential
Reduced Desired Vegetation
Aquatic Plant Decline/Loss of Habitats
Increased Particulate Matter
Structure of Off-Site Resources and Habitats
Livestock or Plant Yields
Wetlands Function
Viability of Aquatic Communities
Good Air Quality
Extent of Natural Habitats
Quality of Cultural and Historic Resources
Survival of T & E Species
Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints

Soil compaction has consequences on the plants themselves. Compaction, in addition to leading to increased runoff, decreases the moisture available to plants and reduces the area into which plant roots can expand. This condition, tied to the ones above, stunts plant growth even further and reduces plant productivity. With plant growth reduced, adverse effects are transferred to the livestock and other animals that depend on those plants for their sustenance.

2.3.1.2 ECOLOGICAL DISCUSSION

SOIL EROSION (System Stressor and Ecological Effect)
Although erosion is a natural geologic process, it is often accelerated by cultivation and resource development. Soils are living, dynamic systems that are altered by changes in water content, temperature, and human activities. Following a disturbance, erosion can result in a variety of forms, wind, gully, sheet, or rill, each having distinctive effects. Soil erosion can have effects on-farm or offsite. In general, erosion from fields used for crop, pasture, or forest production means there is less high quality soil remaining for future production. Onsite erosion damage can reduce the productivity of land, labor, and capital, and increase the need for inputs, such as fertilizer. Erosion degrades soil conditions by lowering organic-matter content, decreasing rooting depth, and decreasing available water capacity.

REDUCED SOIL DEPTH (System Stressor)
Reduced soil depth leads to a decline in the ability of the remaining soil to hold moisture. Also, less area is available for root growth. Soils over bedrock or other impermeable barriers are more vulnerable to this stressor.

REDUCED SOIL MOISTURE AND REDUCED ROOTING AREA (Ecological Effect)
These effects are interrelated and are important aspects in maintaining plant communities, as basic growth is dependent upon them. Roots need air, water, nutrients, and adequate space in which to develop. Changes in these attributes directly affect the health and productivity of the crop plant. The compound impact of these two effects is to reduce the plant's ability for growth by reducing the availability of soil nutrients.

REDUCED AVAILABILITY OF SOIL NUTRIENTS (Ecological Effect)
With reduced soil depth, moisture, and rooting area, nutrients normally available from the soil are lessened. Also, the soil's ability to receive nutrients from outside sources is diminished; sites with lower levels of biomass production less effectively capture and cycle available nutrients compared with sites with high levels of biomass production. A reduced nutrient storage capacity may lead to less efficient use of applied nutrients by crop plants and a greater potential for loss of nutrients to surface and ground water.

REDUCED DESIRED VEGETATION (Ecological Effect)
The above effects lead to an overall decline in desired vegetation. This can result directly from the loss of moisture, nutrient, and/or rooting area. This may also occur as a result of competition with less-desired plants that often don't have the same requirements as the choice community. The desired plants are either out-competed and replaced by opportunistic species or the

community is degraded. Invasion by exotic plant species can out-compete native vegetation and reduce overall vegetative diversity.

LIVESTOCK OR PLANT YIELDS (Assessment Endpoint)
Some runoff and erosion is natural, but accelerated erosion on degraded land reduces the land's production potential. Reduced soil depth inhibits plant growth and diminishes yields. The land may become too xeric for the establishment of grasses or woody plants. Soil erosion can thus change the kind and amount of vegetation the site can produce, perhaps even irreversibly.

This loss of grazing land health means that some options for current and future uses of the land have been lost temporarily or perhaps even permanently. Accelerated erosion is a concern not only where grazing lands have been plowed, but also on lands that are grazed improperly. These effects result in livestock production not being sustainable.

SUSPENDED SEDIMENT (System Stressor)
Sediment is eroded soil that has been deposited into streams, rivers, drainage ways, and lakes. Depending on topography, hydrologic and climatic conditions, eroded soil may be loaded into watercourses or other water bodies. Sediment degrades water quality and often carries soil-adsorbed chemicals and nutrients.

Sediment can increase turbidity that causes decreased light for submerged vegetation. It can also increase water temperature further disrupting the ecosystem and its communities. Suspended sediments can inhibit respiratory function in fish and hinder hunting ability in site-dependent piscivores.

Nitrogen can be carried with sediments into watercourses and water bodies. Excess nitrogen applications can lead to increases in the mass of residual nitrogen that is vulnerable to loss to the environment. Nitrate is soluble and mobile in water and is the form of nitrogen most commonly related to water quality problems.

Phosphorus is strongly bound to sediments by anion adsorption reactions. Most of the total phosphorus loss from cropped land is in the sediment-bound form. The potential for phosphorus delivery to surface waters varies widely among different agricultural practices. Most of the phosphorus load to surface waters is from row crops, particularly on fine-textured soils near watercourses.

Decreased soil erosion does not immediately translate into less suspended sediment in a stream. As the sediment load in runoff water from croplands decreases because of erosion control, the capacity of the cleaner water to pick up sediment in streambeds or stream banks increases. This process continues until the stream channel and the runoff water develop a new equilibrium between the sediment delivered in runoff water and the sediment stored in the stream channel.

SHADING AND SILTATION (System Stressor)
Environmental factors that affect water clarity also affect submerged vegetal growth. The survival of submerged aquatic vegetation depends on the amount of sunlight reaching the plants.

Suspended sediments can detrimentally shade them from sunlight, inhibiting photosynthesis. Reduction of light is thus the primary cause of aquatic vegetation decline.

High levels of nutrients can stimulate the rapid growth of algae, known as blooms. Algae blooms cloud the water and reduce the amount of sunlight reaching vegetation. Certain types of algae grow directly on the plants, further reducing available sunlight.

Siltation of stream and lake beds can smother bottom-dwelling benthic organisms, such as insects, worms, shellfish, and fin fish.

AQUATIC PLANT DECLINE/LOSS OF HABITAT (Ecological Effect)
Aquatic vegetation must be supplied with a sufficient quantity of nutrients to grow and reproduce. Shading inhibits development of both new and existing plants, causing an overall decline in the plant community. Siltation can directly result in the killing of aquatic plants as well as inhibiting growth. Some chemicals that are carried with sediments exacerbate the effect of sediments on aquatic habitats and may destroy fish spawning grounds.

The combined or individual impacts of shading and siltation results in the loss of lower trophic level food sources and habitat. Submerged aquatic vegetation is a valuable source of food, especially for waterfowl. Extensive loss of aquatic vegetation can force some species of waterfowl to migrate to other wintering areas or change their feeding habits.

WETLANDS FUNCTION (Assessment Endpoint)
Wetlands function like natural sponges storing water and slowly releasing it. This reduces the likelihood of flood damage, prevents certain floods, and reduces flood heights. Wetlands also reduce water's erosive potential. Working like a filter, wetlands trap nutrients, sediments, and other materials from entering water bodies. As wetlands are filled with eroded soil, these functions are degraded. Although this is a natural process, it can be accelerated by farming activities.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
Loss of aquatic plants due to sediment, siltation, and shading, affects the entire ecosystem. The fish populations dependent on these food and habitat sources may decline, resulting in reduced food sources for higher trophic level piscivorous avian and mammalian species.

AIR PARTICULATES (System Stressor)
When atmospheric conditions are favorable, wind passing over barren agricultural fields may cause soil erosion. This soil erosion by wind can damage plants through a sandblasting effect. Wind erosion in the United States moves about 2 billion tons of soil annually according to the 2nd RCA Appraisal.

The movement of soil by wind not only damages onsite soil productivity and crop production efficiency, but also degrades air quality by contributing to respiratory illnesses, impairing highway and airport visibility, and increasing cleaning and air purification costs in homes, offices, and factories. A study in New Mexico (Huzar and Piper) based on a survey of

households and businesses found that substantial damages were experienced in the State every year from wind erosion. Based on the survey responses, the authors estimated that annual costs of about $466 million, or $3.00 per ton of wind erosion in the State, resulted from wind blown sediments.

Another consideration is dust that can impair visibility. Several factors limit the size of dust suspended in the atmosphere. For example, the amount of dust released through wind erosion increases with length of field. Moreover, when the soil surface is damp, fine soil particles (potential dust) are bonded to other particles, and dust generation is zero. Under soil conditions wetter than the wilting point or air relative humidity greater than 98 percent, wind erosion and dust generation seldom occur. Since these soil conditions are often not present in the western U.S., most wind erosion and dust generation occurs there.

INCREASED PARTICULATE MATTER (Ecological Effect)
Of particular concern are very small airborne particles less than 0.00001 microns in diameter, referred to as 10-µm or PM_{10}, which have been shown to aggravate respiratory problems such as pneumoconiosis. Periods of soil erosion by wind from agricultural fields may increase the concentration of PM_{10} in the atmosphere.

GOOD AIR QUALITY (Assessment Endpoint)
Air quality is an important agricultural issue, as soil erosion may compromise air quality in some areas of the country. The generation of dust resulting from soil erosion by wind can impair visibility and damage crops. Damaged crops results in lower than expected yields. Reduced vision caused by wind erosion has been identified as the cause of numerous multiple-vehicle accidents in the southwestern U.S.

COMPACTION (System Stressor)
Some crop management practices, such as excessive tillage, the use of heavy machinery, or livestock management, can compact the soil. This hampers the ability of the soil to receive water. Soil compaction impedes seedling emergence and decreases water infiltration, reducing the availability of nutrients for root uptake.

The physical structure, texture, and condition of the soil surface determine the portion of precipitation that runs off or infiltrates soils. In the process, the volume, energy, and timing of seasonal stream flows and recharge to ground water are determined. Soil erosion and compaction degrade the capacities of watersheds to capture and store precipitation.

REDUCED INFILTRATION (Ecological Effect)
Compaction reduces infiltration of water into the soil profile that translates into more runoff and less moisture available for plant use. Movement of water through soils to streams, lakes, and ground water is an essential component of recharge and base flow in the hydrologic cycle.

Stream flow regimes are altered because of reduced infiltration. Seasonal patterns of flow are exaggerated, increasing the frequency, severity, and unpredictability of high-flow periods and

extending the duration of low-flow periods. Reduced water infiltration and water storage can reduce total vegetative biomass production and can result in shifts in species composition.

INCREASED RUNOFF (Ecological Effect)
Normally, soil is able to absorb excess storm water, but as a result of compaction this function is compromised. More water runs off the soil surface instead of entering the soil profile to be stored for plant use or in aquifers. Increased runoff can also augment nonpoint source pollution because water is rushing over the land accumulating soil particles, sediment, pesticides, and nutrients. Increased runoff volume and energy from croplands disrupt water flow regimes, increasing discharge peaks and stream channel erosion. As a result of compaction the potential for flooding is increased.

INCREASED FLOODING POTENTIAL (Ecological Effect)
The normal partitioning of rainfall between infiltration and runoff determines whether a storm results in a replenishing rain or a damaging flood. An increase in runoff and less infiltration often leads to an increase in flooding, increased flood heights, flash floods, or unexpected flooding. The potential flooding may occur on-farm or offsite depending on the watershed and other factors such as amount of rainfall. Collectively over a large area, the impact can be severe.

STRUCTURE OF OFFSITE RESOURCES AND HABITATS (Assessment Endpoint)
Potential offsite impacts may extend from the exacerbation of an expected or unexpected flood event. Normally dry habitat may become impounded with water, disturbing the ecosystem community. Flood events can also upset aquatic habitats due to increased turbidity, temperature changes, and sedimentation. Such an event could be devastating to particular species, thus altering the ecosystem. Increased flood events, such as have been experienced in the Midwest, have devastating effects upon human health, safety, and welfare. Many millions of dollars in damages to land, buildings, equipment, livestock, and crops were realized.

PHYSICAL ALTERATION (System Stressor)
The disturbance or physical alteration of land includes land use conversion or tillage. The physical alteration of land for human needs can have wide-ranging local effects on natural and related resources when done improperly or without prior site assessment.

EXTENT OF NATURAL HABITATS (Assessment Endpoint)
Habitat is the environment that allows plant and animal species to exist, survive, reproduce, and in general conduct normal biological functions to sustain their populations. Habitats can change as a result of either natural or human causes, and different spatial distributions and patterns of food and cover (shelter) result. These changes affect food and shelter availability causing an increase in resource competition between wildlife and/or domestic animals utilizing the remaining habitat to suit their continued needs.

Wildlife habitat may be significantly altered or destroyed. The disturbance can remove habitat and range, and reduce available food and water sources. This forces increased inter- and intra-species competition in areas where food, water, shelter, or nesting resources have been reduced

or altered by the disturbance. Competition may ensue for any one of these resources or for all of them, depending on the level of disturbance and species requirements.

When habitat becomes altered through changed vegetative or animal patterns, the habitat is no longer capable of supporting the variety of species that previously had been there. It may become so dramatically changed that it can no longer support any species, even those that might have invaded to replace those forced out. At that point the habitat is degraded and is basically non-functional.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Increased competition and fewer resources may affect threatened and endangered species more than other species. Threatened and endangered species are less able to adapt to quickly-changing surroundings, as their habitat requirements are often more specialized than other species. In addition, because these species have been identified as threatened and endangered, their populations are already depressed. Any further stress could be detrimental to species survival.

QUALITY OF CULTURAL AND HISTORIC PROPERTY RESOURCES (Assessment Endpoint)
Unidentified archeological sites and artifacts may be degraded or completely destroyed during the physical alteration of the soil mantle. Cultural and historic property resources that are buried or imbedded in the soil generally derive their importance from the relational context of site objects, features, association, and location. Archeological sites are layered, and often contain unique, nonrenewable cultural deposits with associated environmental information.

An altered site loses integrity (layers) and is more difficult to interpret as data and relationships can be more difficult to establish, if it all. Some cultural resources and/or locations have distinctive cultural association or religious significance to Native American and other ethnic populations. All cultural resources have intrinsic heritage value to the general population, and some have economic values associated with education and tourism.

2.3.2 IRRIGATION WATER APPLICATION

Irrigation is the application of water on lands to assist in the growth of crops or pastures or to maintain vegetative growth in recreational lands, such as parks, lawns, and golf courses. Irrigation water is supplied from groundwater or surface waters such as a stream or lake.

Four irrigation methods are:

1. Sprinkler irrigation in which water is sprayed (sprinkled) through the air to the ground surface.
2. Surface irrigation in which water is distributed over the soil surface by gravity flow.
3. Micro-irrigation, which is the frequent application of small quantities of water as drops, tiny streams, or miniature sprays through emitters or applicators placed along a water delivery line.

4. Subsurface irrigation in which water is applied below the ground surface by raising the water table to within or near the root zone.

The principal environmental issues relevant to irrigation are those concerned with the protection and management of water supplies and water quality. Pollutants from irrigated agriculture are sediment, total dissolved solids (salts, salinity), trace elements, nutrients (phosphates and nitrates), and pesticides. Natural processes supply some of these pollutants. Separating irrigation-induced impacts from naturally induced impacts requires site-specific data and intensive studies. Transpiration and evaporation of water results in increasing the concentration of salt constituents in the water. Additionally, salt contaminant loads are increased with salts added from return flows from agricultural fields and from soil substrata.

Water use by irrigated agriculture has created significant environmental impacts in many areas. The magnitude of the impacts, both beneficial and adverse, varies with geographic location, as summarized below:

a) Seepage from both conveyance and onfarm distribution systems has created many diverse forms of fish and wildlife habitat, which were not present previously. However, the habitats created may be only marginal in terms of their capability of sustaining significant populations of small game, waterfowl, and other residents of these systems.

b) Seepage from irrigation conveyance systems and inefficient water use has increased recharge of subsurface waters and aquifers, but the water tends to be of poor quality.

c) Diversions from some streams have impaired aquatic communities and migration of anadromous fish.

d) Return flows from irrigated areas may contain biocidal residues, nutrients, and sediment, and may reduce the quality of many facets of the environment.

e) Water depletions of ground and surface waters have been attributed to an excessive use of available water.

Basic principles of irrigation water diversions, application, and utilization need to be considered in relation to the management of water within a river basin. The attached figure shows the relationship between irrigation diversions, water use, and river basin hydrology.

2.3.2.1 ECOLOGICAL PORTRAIT

Irrigation is a practice that has allowed humans to utilize areas that otherwise could not be productive from an agricultural standpoint. Having water and having the right amount of water allows farmers to grow crops in very dry regions of the country, but ecologically there are

conditions created that need to be corrected when irrigation waters are added to areas where traditionally there has been very little precipitation on a annual basis for thousands of years.

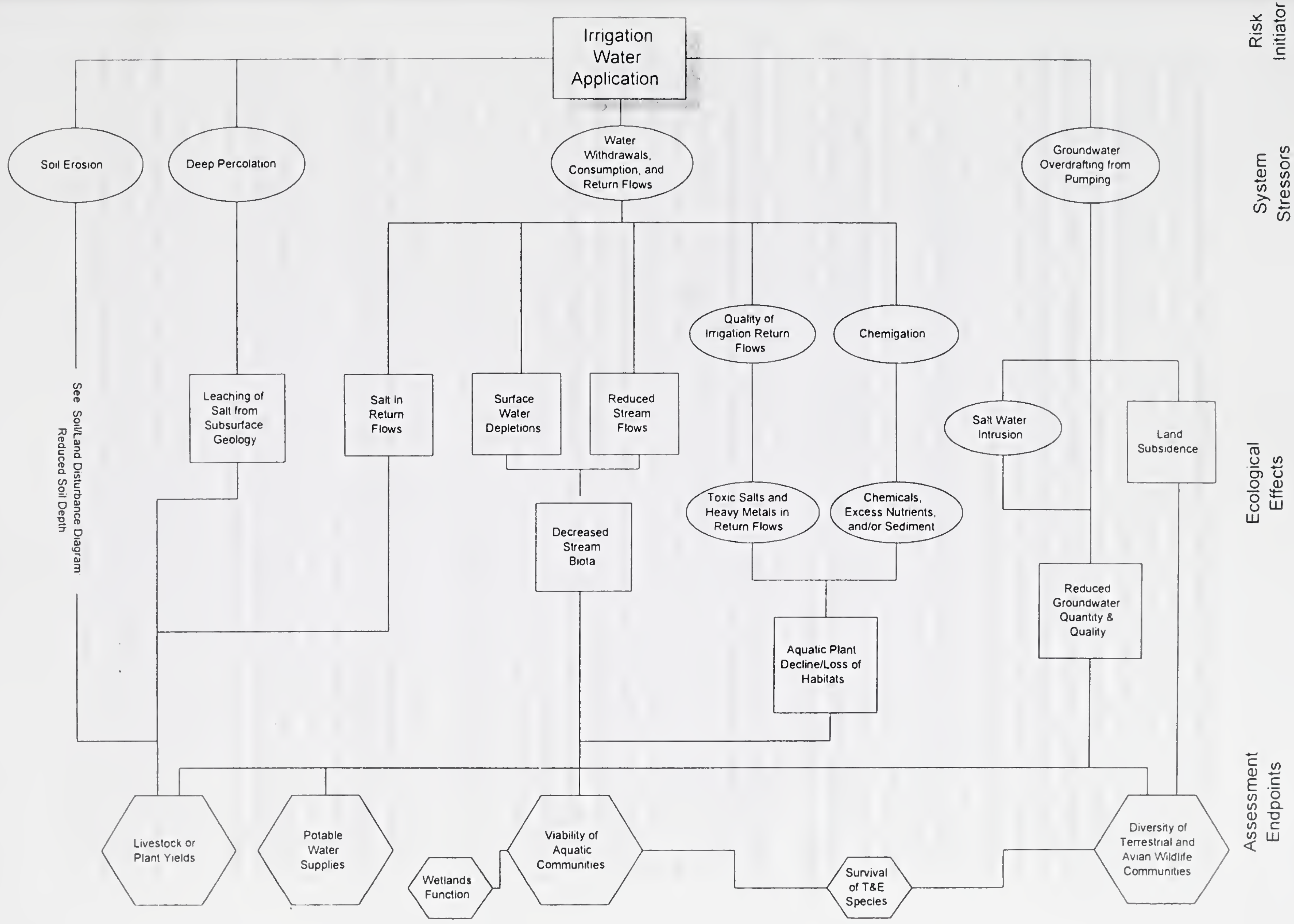
Ecologically irrigation water is the ultimate recyclable material, which is part of the ecological problem. Since irrigation waters are used over and over in a very short distance and time frame, the possibility of contamination, especially from salts becomes very high. There are few materials in our society that are recycled in such a short time period without "replenishment" as is irrigation water. Overlaying on top of that aspect is the fact that many Western States sit on geologic structures that are laden with salt deposits from a prehistoric inland sea of millions of years ago, thus multiplying ecological problems.

In addition to the "natural" salts that are picked up by irrigation waters as they flow through salt-laden geologic structures, other chemicals, such as heavy metals (e.g. selenium) become entrained in the water flow. These can have life-threatening effects on animals that drink the water. Also, the chemicals can reach healthy aquatic habitats and produce damage to aquatic plant and animal communities, that are exposed to the contaminated irrigation waters. For the aquatic communities ecological decline and loss of viable habitats is inevitable. With the loss of aquatic communities, threatened and endangered species cannot be supported in their ecological functions, so they too are adversely affected. Keeping contaminated irrigation waters separate from potable drinking-water supplies is an inherent problem when irrigation waters are integral parts of watersheds.

If irrigation waters are pumped via center-pivot irrigation systems or other large-scale pumping systems, thousands of gallons of water are sprayed onto fields each day. While recent innovations have reduced many of the older high-volume spraying operations, much water can be lost to evaporation or runoff if irrigation management is not carefully performed. Even in areas where it seemed a few years ago that the water supplies were "inexhaustible," farmers are not so sanguine as they once were about water availability. Water conservation needs to be an important part of conservation planning.

Ecologically, large-scale pumping can lead to land subsidence and salt-water intrusion on a large geologic scale. The result of these actions can be reduced groundwater quality and, eventually, the quantity of available water. Additionally, since water gets used and reused, it becomes just a question of time before recycling of poor quality "reused" water becomes the norm in an area rather than the exception.

The situation is analogous to the surface-water pollution situation of the 1950s and 1960s when prior to that time surface waters were routinely used in homes and factories and then reentrained into nearby streamflows. Even with this usage there was sufficient time for the water to undergo basic natural treatment before it reached the next town or city. However, with the great demands for goods and services that grew out of the post World War II expansion and growth, water has not been able to get sufficiently clean through natural treatment before it reached the next town or city. Consequently, municipalities further downstream were extracting polluted water most of the time. The lesson should not be lost on irrigation and its relation to groundwater supplies.



Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints
Irrigation Water Application
Soil Erosion
Deep Percolation
Water Withdrawals, Consumption, and Return Flows
Groundwater Overdrafting from Pumping
Quality of Irrigation Return Flows
Chemigation
Leaching of Salt from Subsurface Geology
Salt in Return Flows
Surface Water Depletions
Reduced Stream Flows
Salt Water Intrusion
Land Subsidence
Toxic Salts and Heavy Metals in Return Flows
Chemicals, Excess Nutrients, and/or Sediment
Decreased Stream Biota
Reduced Groundwater Quantity & Quality
Aquatic Plant Decline/Loss of Habitats
See Soil/Land Disturbance Diagram
Reduced Soil Depth
Livestock or Plant Yields
Potable Water Supplies
Wetlands Function
Viability of Aquatic Communities
Survival of T&E Species
Diversity of Terrestrial and Avian Wildlife Communities

There is a toll to avian and terrestrial communities from irrigation, even when irrigation is properly done. From an ecological standpoint all of these biotic communities developed and adapted to their surroundings over thousands, if not millions of years. Then, over a relatively short period of time the entire distribution of water for the area is changed from a random distribution of small amounts to a collected, contained, and channeled distribution to sustain agricultural uses as well as towns and cities. While the net amounts of water have not changed appreciably over time, the availability of water to these biotic communities has. Often, water is now available to these biotic communities when humans give it to them or it escapes from the irrigation devices through inefficiencies in the systems.

The net result is that even though water distribution was uneven for thousands of years, it was available to biotic communities, and these communities developed where the water was predominantly available. However, with irrigation as a method to capture, control, and dispense water, there are large areas of the landscape that are depleted of water supplies where previously there had been a supply. As a result of those water depletions, areas that previously were dry but with occasional water, are now desert.

Water distribution changes have caused shifts in species populations and composition with desert species replacing xeric species. The shifts are not only displayed in terrestrial and avian communities, but also in the aquatic communities. Streams that previously flowed most of the year, no longer do so. Instead, they may only flow for three months of the year. Streams that previously were classified as continual flow are now classified as intermittent. Species' changes and biotic communities' changes reflect those water distribution changes. The changes in distribution of water could cause a species, whose population is precariously low, to be placed on the threatened species list or could cause it to go from the threatened species list to the endangered species list.

2.3.2.2 ECOLOGICAL DISCUSSION

WATER WITHDRAWALS, CONSUMPTION, AND RETURN FLOWS (System Stressor)
To deliver a given amount of irrigation water to an irrigated crop, it is necessary to divert from the supply source amounts of water greater than that to be consumed by the crop. This diverted water may include return flow from other areas.

Diverted water may leave the irrigated area as crop evapotranspiration, seepage from the conveyance system (canals and onfarm ditches), operational spills, deep percolation, tailwater runoff, evaporation, or as phreatophyte and hydrophyte consumption.

The water consumed by evaporation from an irrigated crop is only slightly affected by the method or efficiency of irrigation as long as the water available to the crop's roots is not limiting. Some of the problems resulting from ineffective use of irrigation water are caused by the volume and timing of irrigation water pumped or diverted, relative to crop needs. Large withdrawals on some streams leave remaining instream flows inadequate for aquatic life, recreation, and water

quality maintenance between the point of diversion and the areas of return flow from the irrigation.

SOIL EROSION (System Stressor)
Sediment in irrigation return flows may cause water use impairment from sediment pollution and agrichemicals transported by the sediment. This causes major water-quality degradation problems in several rivers in the Western United States, harming fish and other aquatic life.

Erosion reduces the agricultural productivity of fields and causes off-farm damages. In southern Idaho, crop yield potential has been reduced by 25 percent due to 80 years of irrigation- induced erosion. Sedimentation effects in ditches and canals from irrigation induced erosion can be substantial.

DEEP PERCOLATION (System Stressor)
Water seepage varies depending on the condition of canals and onfarm ditches. Piped or lined conduits have lower seepage amounts than unlined channels. Most seepage and deep percolation waters return to natural stream channels either directly via drains or indirectly through groundwater aquifers. Return flows reaching natural stream channels become available again for instream use or downstream diversion. However, return-flow water quality may be degraded. The recharge to aquifers serves to maintain groundwater supplies.

CHEMIGATION (System Stressor)
Chemigation can be defined as the application of a chemical via an irrigation system by injecting the chemical into the water flowing through the system. Chemicals being applied by this technique include fertilizers, herbicides, insecticides, fungicides, nematicides, growth regulators, and biocontrol agents. Although chemigation has many advantages, potential risks from its use include chemical back flow into the water supply; non-uniform chemical distribution; non-target chemical application as a result of drift, malfunctioning equipment, and runoff; excessive over or under application of the chemical; or lack of proper calibration or careful and attentive management.

GROUNDWATER OVERDRAFTING FROM PUMPING (System Stressor)
The major impact of irrigation on groundwater aquifers in areas where the water is supplied from the aquifer results from the consumptive use for crop production or other purposes. In shallow or moderately deep aquifers, most seepage and surface return flows will find their way back to the aquifer. However, a reduction in return flows to the groundwater generally will reduce the rate of quality degradation. Where water is pumped from deep aquifers, the time of return is slow and questionable. Therefore, the total withdrawal can be considered a depletion of the aquifer. Any reduction in withdrawal demands will prolong the life of these deep aquifers.

In areas where conjunctive use of surface- and groundwaters is practiced, or surface water is the primary supply, total withdrawals are expected to effect groundwater supplies only to the extent that consumptive use exceeds the surface water supply.

When irrigation water is pumped from ground or surface water supplies, energy requirements are direct proportion to the volume of water pumped. Thus, excess water applications increase energy use and require greater capacity pumps, engines, and distribution conduits. In areas, such as the Texas High Plains, where groundwater pumping exceeds the recharge rate of the aquifer, excess use of irrigation water decreases the useful life of the groundwater aquifer, and can, eventually, lead to land subsidence.

Seepage from irrigation conveyance systems and inefficient water use, in some instances, has increased recharge of aquifers. Diverted irrigation water that recharges a groundwater aquifer through seepage or deep percolation adds to the water supply available to groundwater users. Some farms and small communities depend on these replenished supplies. In some cases, aquifers are used to store and distribute excess surface supplies. "Irrecoverable ground water" is ground water resulting from seepage or deep percolation that is not recoverable or usable.

LAND SUBSIDENCE (Ecological Effect)

Land subsidence from groundwater overdrafting is caused by compaction of the aquifer structure, that lowers surface elevation. The land's susceptibility depends on the geologic structure of the aquifer. Groundwater subsidence areas are concentrated in Texas, California, Arizona, and Nevada. Nationwide, annual losses from lowered surface elevations due to underground fluid withdrawal, mainly groundwater, are estimated at $35 million (National Research Council, 1993). In addition to monetary losses, compaction causes a permanent loss in the aquifer's capacity to store water, thus reducing the potential for natural and artificial recharge.

SALT WATER INTRUSION (System Stressor)

Water obtained from wells is frequently contaminated by saltwater intrusion. The salinity of groundwater generally increases as depth increases. This phenomenon is related to the original deposition of the salt-bearing formations, the movement of ground water, and the movement of individual ions over time. The salinity of ground water is also traceable to other factors, such as proximity to oceans, leakage wells, and leaching from surface sources.

The most frequent cause of saltwater intrusion is excessive pumping or groundwater mining. Since irrigated agriculture is a heavy user and consumer of groundwater, it may contribute to saltwater intrusion in some locations.

SURFACE WATER DEPLETION (Ecological Effect)

Diversions from some streams have impaired aquatic communities and migration of anadromous fish. In the western States, high early-season streamflows from snowmelt are diverted near the headwater. The entire diversion, irrigation, and return flow process may take from a few hours to a few months. The delays occur when a significant amount of flow returns through the ground-water system. These returns supplement the later season low flows that normally occur. The net effect is similar to reservoir storage in the basin. Thus, large increases in system efficiencies of upstream irrigation projects may require additional water storage to provide the same downstream water supplies later in the season.

Operational spills result from a reduction in demand for water within the system after the water has been withdrawn from the supply source. These spills usually return to the natural stream channels via wasteways and become available for instream or downstream uses.

With each diversion, a portion of the water is permanently consumed through evapotranspiration of the irrigated crop. The net effect is a decrease, in some cases a substantial decrease, in the total annual flow of the stream as it moves downstream.

TOXIC SALTS AND HEAVY METALS IN RETURN FLOWS (System Stressor)
A small quantity of deep percolation (movement of water downward below root zone) is necessary to remove salts that would otherwise accumulate within the root zone, hampering and eventually prohibiting plant growth. This water is referred to as the leaching requirement and the quantity depends on soils, crops grown, climate and water quality.

High concentrations of inorganic trace elements in irrigated soils and shallow groundwater pose a threat to agricultural production and the health of humans and animals. They do so in three ways: 1) trace elements can accumulate in plants to levels that cause phytotoxicity; 2) trace elements in plants can adversely affect humans and animals that consume those plants; and 3) trace elements can migrate with seepage through the root zone and into ground water, possibly re-emerging with subsurface drainage in surface waters, thereby affecting wildlife, or as with groundwater pumped, or surface water used for domestic use, threatening the health of humans.

SALTS IN RETURN FLOWS (Ecological Effect)
Salts are a product of the natural weathering process of soil and geologic material. They are present in varying degrees in all soils and in fresh water, coastal waters, estuarine waters, and groundwaters.

In soils that have poor subsurface drainage, high salt concentrations are created within the root zone where most water extraction occurs. The accumulation of soluble and exchangeable sodium leads to soil dispersion, structured breakdown, decreased infiltration, and possible toxicity. Thus, salts often become a serious problem on irrigated land, both for continued agricultural production and for water quality considerations. High salt concentrations in streams can harm freshwater aquatic plants just as excess soil salinity damages agricultural crops. While salts are generally a more significant pollutant for freshwater ecosystems than for saline ecosystems, they may also adversely affect anadromous fish. Although they live in coastal and estuarine waters most of their lives, anadromous fish depend on freshwater systems near the coast for crucial portions of their life cycles.

The movement and deposition of salts depend on the amount and distribution of rainfall and irrigation, the soil and underlying strata, evapotranspiration rates, and other environmental factors. In humid areas, dissolved mineral salts have been naturally leached from the soil and substrata by rainfall. In semi-arid regions, salts have not been removed by natural leaching and are concentrated in the soil. Soluble salts in saline and sodic soils consist of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, and chloride ions. They are

easily leached from the soil. Sparingly soluble gypsum and lime also occur in amounts ranging from traces to more than 50 percent of the soil mass.

Irrigation water, whether from ground- or surface-water sources, has a natural base load of dissolved mineral salts. As the water is consumed by plants or lost to the atmosphere by evaporation, the salts remain and become concentrated in the soil. This is referred to as the "concentrating effect."

The total salt load carried by irrigation return flow is the sum of the salt remaining in the applied water plus any salt picked up from the irrigated land. Irrigation return flows provide the means for conveying the salts to the receiving streams or groundwater reservoirs. If the amount of salt in the return flow is low in comparison to the total stream flow, water quality may not be degraded to the extent that use is impaired. However, if the process of water diversion for irrigation and the return of saline drainage water is repeated many times along a stream or river, water quality will be progressively degraded for downstream irrigation use as well as the other uses.

LEACHING OF SALT FROM SUBSURFACE GEOLOGY (Ecological Effect)
Depending on geologic conditions, deep percolating water may slowly flow to deep aquifers or may enter stream systems through natural or manmade drainage systems. Deep percolation is often excessive as a result of poor irrigation management or nonuniform application inherent in many irrigation systems.

Deep percolating waters may come in contact with ancient lake and seabed deposits, picking up additional salts on the way back to groundwater or surface flows. There is also displacement and mixing of saline water in the underlying aquifer by deep percolating irrigation water. Where deep percolating irrigation waters contact saline aquifers or geologic formations high in salt, the returning waters may have salt concentrations 10 times that of the diverted water.

QUALITY OF IRRIGATION RETURN FLOWS (System Stressor)
Filling the root zone on graded irrigation systems results in tailwater runoff at the lower end of a farm field. The amount of runoff depends on soil conditions, irrigation system design, and water application methods. Some tailwater runoff may be unavoidable when graded surface irrigation systems are operated to achieve adequate infiltration and water application uniformity. Tailwater may evaporate, percolate, be consumed by phreatophytes, or reach stream channels as surface- or groundwater-return flow. Runoff may be collected onfarm and pumped back into the delivery system for reuse, or may be intercepted by other users as a supplemental or primary water source.

Surface runoff often carries sediments eroded from irrigation fields or drainage channels. The suspended sediment produces unfavorable conditions of aquatic life in receiving rivers and reservoirs.

Return flows to natural stream channels resulting from tailwater runoff, drainage flows, operational spills or groundwater discharge may provide all or a portion of a downstream user's

water supply. Return flows from irrigation sources often increase the sustained flow in smaller streams to the extent that the stream can support limited fisheries not otherwise available.

REDUCED STREAM FLOWS (Ecological Effect)
Diverting less water for irrigation would change the overall consumptive use on the irrigation project significantly. Additional water would be available for nonconsumptive instream uses between the points of diversion and return flow. The water would be available during the time the diversion would have been made, in the absence of reservoirs to store it.

Many irrigation projects have been developed, at least in part, in consideration of return flows and reuse. The streamflow in the lower reaches of most streams does not consist of new water, but of return flows of water previously diverted from the system in the upstream reaches. Thus, the system storage and return flow provided by current irrigation practices affects other water-related development. Any irrigation improvements that alter this system need to be carefully considered.

DECREASED STREAM BIOTA (Ecological Effect)
A more accurate picture of the impact of irrigation can be presented by considering resident fish and anadromous fish separately. Resident fish live their entire life spans in a local stream reach, reservoir, or in some cases both. The well-being of stream fisheries is directly influenced by the instream flow conditions. Some species are intolerant of changes in their environment. Other species are very tolerant of such changes. Generally, the more desirable game fish are less tolerant than the "rough" fish. Therefore, shifts in species composition have occurred, and depending on the local conditions, could be deemed either desirable or undesirable. Reservoir fisheries may benefit from water conservation measures that result in reducing reservoir drawdown and improving quality of inflows.

Anadromous fish spend a part of their lives in saltwater, but return to freshwater to reproduce. They are found in many of the tributary streams flowing into the Nation's coastal waters, but of primary importance are those streams tributary to the Pacific Ocean. Important anadromous fish The situation is analogous to the surface-water pollution situation of the 1950s and 1960s when prior to that time surface waters were routinely used in homes and factories and then reentrained into nearby streamflows. Even with this usage there was sufficient time for the water to undergo basic natural treatment before it reached the next town or city. However, with the great demands for goods and services that grew out of the post World War II expansion and growth, water has not been able to get sufficiently clean through natural treatment before it reached the next town or city. Consequently, municipalities further downstream were extracting polluted water most of the time. The lesson should not be lost on irrigation and its relation to groundwater supplies.

There is a toll to avian and terrestrial communities from irrigation, even when irrigation is properly done. From an ecological standpoint all of these biotic communities developed and adapted to their surroundings over thousands, if not millions of years. Then, over a relatively short period of time the entire distribution of water for the area is changed from a random distribution of small amounts to a collected, contained, and channeled distribution to sustain agricultural uses as well as towns and cities. While the net amounts of water have not changed

appreciably over time, the availability of water to these biotic communities has. Often, water is now available to these biotic communities when humans give it to them or it escapes from the irrigation devices through inefficiencies in the systems.

The net result is that even though water distribution was uneven for thousands of years, it was available to biotic communities, and these communities developed where the water was predominantly available. However, with irrigation as a method to capture, control, and dispense water, there are large areas of the landscape that are depleted of water supplies where previously there had been a supply. As a result of those water depletions, areas that previously were dry but with occasional water, are now desert.
include several salmon species, steelhead trout, smelt, sturgeon, and striped bass. Many of the streams in the mountain meadow, intermediate valley, and lower valley areas in California, Washington, Oregon, and Idaho provide the desired spawning, incubation, and rearing areas in addition to passageways for anadromous fish species. Reservoirs and irrigation water diversions have significantly contributed to changes of instream flows and the associated biota in waters tributary to the Pacific Ocean. In the mountain meadow setting of the Pacific Northwest, salmon and steelhead fingerlings and smolts may be diverted onto irrigated lands to perish where diverted water are not properly screened.

Water and power developments in California have had a significant impact upon migrations of salmon and steelhead smolts in addition to striped bass. Irrigation in the intermediate and lower valleys decreases instream flows for spawning, incubation, and rearing of juveniles at critical times. Decreased streamflows and increased pollutant loading from return flows from agriculture areas effect estuaries. A reduction of sedimentation and pesticide residues would greatly assist in sustaining, protecting, and perhaps perpetuating the biotic communities common to the estuarine environment. Maintenance of this estuarine habitat is critically important to anadromous fish. The potential increase in survival would provide beneficial impacts to the commercial and sport fishing industry. The increased survival would assist in the perpetuation of specific races of fish species, thus keeping them off the Endangered and Threatened Species List.

DIVERSITY OF TERRESTRIAL AND AVIAN WILDLIFE COMMUNITIES (Assessment Endpoint)
Increased salt levels in surface water can have negative effects on terrestrial and avian wildlife communities. While there are different wildlife species in the various characterization regions and irrigation settings, these impacts can be generalized by discussing the major wildlife groups.

Waterfowl, shorebirds, herons, and other species dependent upon wetlands and seeps benefit from conveyance losses, tailwaters, and operational spills. Without these losses there would be significantly less wildlife habitat associated with irrigation water use, without mitigation.

Removal of phreatophytes to reduce incidental losses would have an adverse impact on nesting waterfowl, upland game, small mammals and songbirds and other nongame animals. Also, drainage ditches and wasteways provide habitat for many game and nongame species. Any reduction of excess diversions and irrigation applications can be expected to reduce or change the value of these areas.

Threatened and endangered species inhabit some irrigated regions and may have adverse responses to the effects of implementing water conservation measures. Specific studies would be required to establish whether such responses would occur and to formulate compensating measures to ensure the continued existence of these populations and their habitats.

Big game animals (especially deer), and other terrestrial wildlife, as well as children have drowned in large, irrigation canals.

Groundwater functions to recharge surface water bodies. If over-drafted, surface waters (including streams and wetlands) may be lost. Surface water also flows to recharge groundwaters. Over-drafting of groundwater may cause a loss of surface water bodies as they are drawn down to recharge groundwater. This also may lead to the creation of sink holes through land subsidence. Sink holes provide direct access to groundwater through which contamination may occur.

WETLANDS FUNCTION (Assessment Endpoint)
Phreatophyte or hydrophyte consumption is noncrop vegetative transpiration of water that may occur adjacent to streams and channels or in areas of shallow water tables. The existence of this vegetation often provides or enhances wildlife habitat (also see Soil/Land Disturbances Diagram). Seepage from both conveyance and onfarm distribution systems has created many diverse forms of fish and wildlife habitat. Habitat impacts carry over to riparian ecosystems and affect small game, waterfowl, and other residents of these systems.

POTABLE WATER SUPPLIES (Assessment Endpoint)
Salinity in water can increase human health risks, reduce the effectiveness of household cleaning compounds, cause metal corrosion, and coat the inside of pipes and boilers. Salinity greatly complicates water treatment and consequently increases treatment costs. Dissolved solids do not respond to the usual settling and filtration techniques used for suspended materials. Removing dissolved substances requires ion exchange, chemical precipitation, distillation, or reverse osmosis.

Nitrogen, phosphorus, pesticides, and trace elements when concentrated in surface water or groundwater may become toxic pollutants when consumed in drinking water by humans and animals.

LIVESTOCK OR PLANT YIELDS (Assessment Endpoint)
Pollutants such as increased salts, trace elements, nutrients, and pesticides in irrigation return flows, as well as depletions of overall ground and surface water supplies has additional affects on livestock and plant yields over and above those previously discussed in the Soil/Land Disturbance diagram.

Plant vigor can be adversely affected by the addition of salts and other elements through toxicities to the plant itself. This will limit the types and kinds of vegetation available to the producer, and will also tend to limit the overall usage of the land itself. Additional inputs of

nutrients in water supplies introduced by irrigation return flows could encourage excessive plant growth of both desirable and undesirable species, however, it will also increase the potential for excess uptake of the elements in the plant tissue, again with the potential for toxicities.

With overutilization of the water source, depletions become a source of concern to those users further downstream, or to those users with lesser water rights. Depletions of the ground and surface supplies becomes critical in maintaining adequate desirable vegetation to support livestock operations. Plant diversity, needed to support other species, including, threatened and endangered species can be reduced through overuse of the current water supply.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
With the addition of salts, pesticides, herbicides, and sediment due to irrigation and in irrigation return flows, aquatic communities can be adversely affected due to loss of plant diversity. Plants that are not salt tolerant will no longer grow, which in turn will affect the kinds and type of species that can be supported by the land and water resources. (See Soil/land Disturbance diagram explanation, as well as discussion on Livestock or Plant Yields from the Irrigation Applications diagram.)

Through the loss of a stream's intermittent flow, stream biota become impacted, further impacting aquatic communities dependent on these organisms dependent for food and habitat. Additionally, loss of habitat and aquatic plants further impact other species, both avian, terrestrial, and fish, due to increased loss of food and habitat.

Groundwater overdrafting has resulted in the desertification of sensitive habitats, namely those with little available water. Aquatic communities become stressed and species diversity is altered or declines.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Increased competition for water will have effects upon threatened and endangered species by reducing the desirable vegetation needed to support habitats. Increased salinity from irrigation return flows will also limit the types and kinds of vegetation available for habitat, therefore placing limits on the kinds of species making their homes in an area. The overall effects are not limited to the kinds of vegetation able to support the threatened and endangered species, but also the amount and quality of the water itself will be a limiting factor on the species using an area for habitat. As with the previous discussions for livestock and plant yields and aquatic communities, as well as those discussions in the Soil/Land Disturbance diagram, effects from irrigation applications can have serious affects on the threatened and endangered species in a location.

2.3.3 PESTICIDE APPLICATION

Pesticide application includes the use of both herbicides for weed control and insecticides for insect control. Most compounds are broadcast or injected into the soil by tractor-mounted or towed with spray equipment, but some aircraft delivery of dry-form compounds is conducted. Herbicides are the predominant pesticide, accounting for 85 percent by volume of the pesticides

used on major field crops. Insecticides account for about 13 percent of total pesticide use on major field crops (USDA ERS 1991). Highest levels of pesticide expenditures are in Florida, California, Washington, the Mississippi River Valley, and the Midwest.

Once a pesticide is applied, fate and transport of the compound are controlled by several processes. These include photo decomposition, chemical degradation, biological degradation, volatilization, plant uptake and metabolism, adsorption to soil in runoff, and leaching. Microbial degradation is the most common route of pesticide degradation and soil conditions that favor microbial activity can result in an increased rate of pesticide degradation. Adsorption is the binding of pesticides to soil particles and affects the potential movement of a pesticide to ground or surface water. Runoff is the surface movement of pesticides in water. Pesticides can move either dissolved in water or adsorbed to soil particles. Leaching is the movement of pesticides in water through soil and is dependent on pesticide properties and soil permeability. Deep percolation or runoff of pesticides require rainfall or irrigation. Tillage practices can influence both runoff and deep percolation.

2.3.3.1 ECOLOGICAL PORTRAIT

The ecological outlook concerning pesticide use has significantly improved over the last two decades. Several bird species, which previously were on the threatened or endangered species lists, have been removed because the species' populations are rebounding from the low levels of the 1950s and 1960s. Chemical manufacturers have developed agricultural pesticides that have relatively short half-lives, so after several weeks much of the chemical has broken down in the environment into relatively harmless compounds. Farmers and ranchers have had to pay relatively higher prices for chemicals in recent years, in part to cope with the previous two developments, so farmers have been much more aware of how and when to use chemicals and in what amounts. Using techniques such as precision farming, the linking of geographic positioning system and geographic information systems to more accurately place the types and amount of chemical or fertilizer is a new technology being used by farmers and ranchers. The technology is new and somewhat expensive to utilize, so smaller farmers may not have the means to fully utilize these technological breakthroughs to farming and ranching.

However, from an ecological standpoint, nature still has to deal with chemical compounds that are totally alien to anything developed in nature over millions of years, and the public as a group is still very distrustful of situations where chemicals could be part of the food they eat or be part of the environment in which they live. Also, the public is wary of situations where chemicals are involved in large-scale operations, such as a refinery or in farming.

While graphic illustrations of chemical abuse may have planted negative feelings about chemicals in the public's minds, the public's attitudes and perceptions towards chemicals is real and needs to be realistically addressed in any ecological risk assessment. Part of that appropriate risk assessment has been turned into political action with the signing by President Clinton of the Executive Order on Environmental Justice (E.O. 12898; Feb. 11, 1994). This order directed

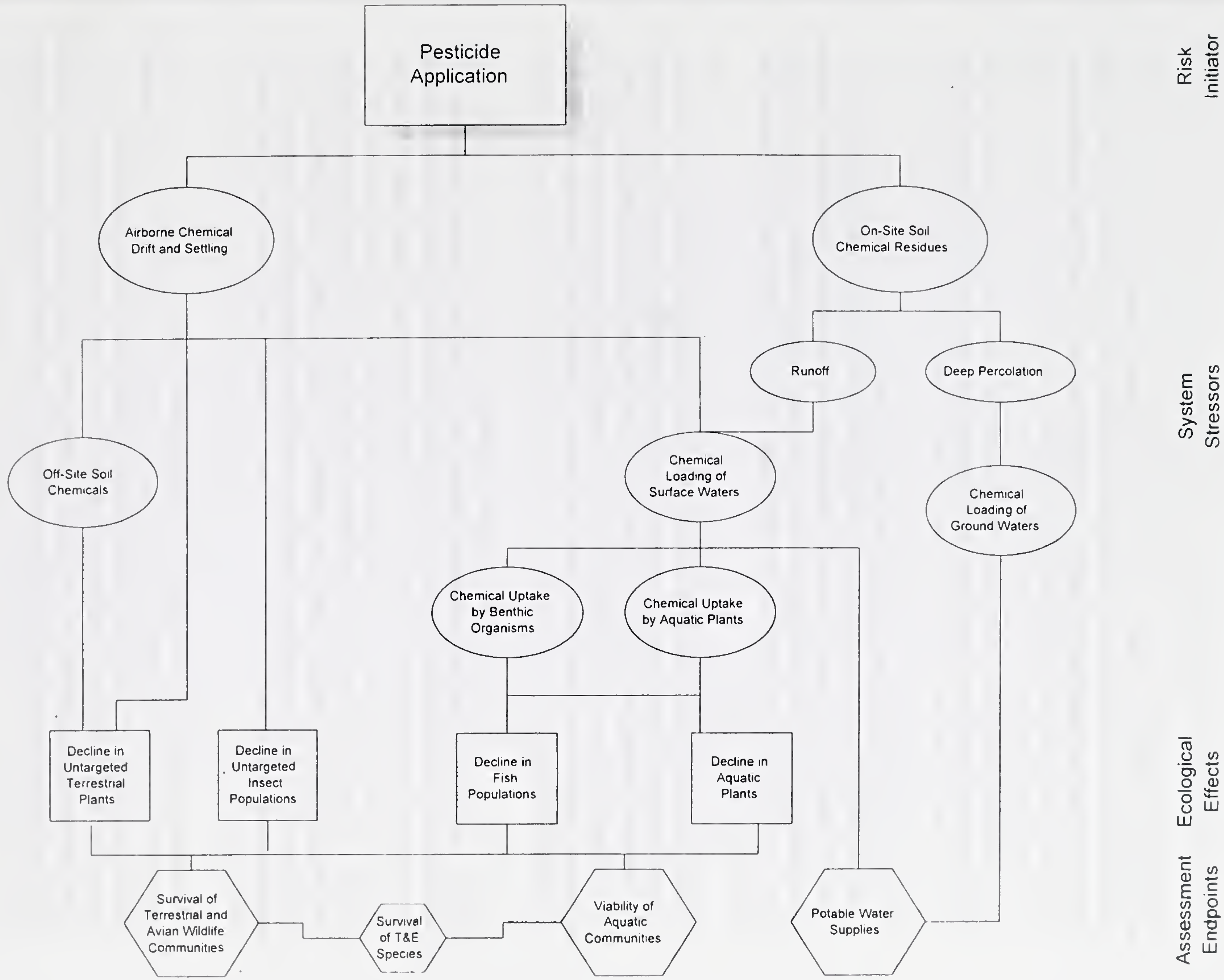
Federal agencies to identify and address the issue of environmental justice, or adverse affects to human health and environmental effects, of agency programs that disproportionately impact minority and low-income populations. The Executive Order specifically directs agencies to consider patterns of subsistence hunting and fishing when an agency action may affect fish or wildlife.

The Executive Order applies to the use of chemicals in agriculture as well. Two of the greatest environmental stressors in pesticide applications are the onsite use of chemicals mentioned above and the offsite consequences of chemical use from farms and ranches. While farmers generally are careful about pesticide applications, either because of costs or personal fears in handling, many millions of acres receive chemicals to control pests, either plant or animal.

Since pesticides must be applied rapidly and in large quantities relative to the large acreages involved, the "shotgun" approach is often used, rather than the "surgical" approach. Airborne chemical applications are done with as much precision as the methodology allows, but the coverage is the complete field and everything on it. Ecologically, it can sterilize the entire field even though the object of the application was a specific animal or plant target.

With a widespread broadcast, such as aerial application, airborne drift is something to constantly guard against, but in spite of controls, chemicals do aerially drift offsite or they can become entrained in runoff and move in the water to watercourses and water bodies. Chemicals that leave the field can have direct effects on human populations by contaminating drinking water supplies, either as wells or as reservoirs.

In extreme cases, as a result of chemicals reaching offsite areas, there can be chemical uptake of the chemicals by organisms or plants causing fish kills directly or indirectly when aquatic vegetation dies creating a deficit of dissolved oxygen. In other cases, chemicals escaping from fields can cause a decline in untargeted terrestrial or aquatic plants and animals. Species populations can change and undesirable plants and animals invade to occupy the empty niches that result. This, in turn, creates the need to use even more chemicals to control the undesirable, invading species. Ecologically, it becomes a doubly reversing, accelerating situation, that may in the end not have the positive, protective benefits that the farmer or rancher was seeking.


Pesticide Application
Airborne Chemical Drift and Settling
On-Site Soil Chemical Residues
Runoff
Deep Percolation
Off-Site Soil Chemicals
Chemical Loading of Surface Waters
Chemical Loading of Ground Waters
Chemical Uptake by Benthic Organisms
Chemical Uptake by Aquatic Plants
Decline in Untargeted Terrestrial Plants
Decline in Untargeted Insect Populations
Decline in Fish Populations
Decline in Aquatic Plants
Survival of Terrestrial and Avian Wildlife Communities
Survival of T&E Species
Viability of Aquatic Communities
Potable Water Supplies
Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints

2.3.3.2 ECOLOGICAL DISCUSSION

AIRBORNE CHEMICAL DRIFT AND SETTLING (System Stressor)
Aerosolized liquid and airborne dry compounds may drift from the application site to settle on offsite vegetation and surface water bodies. The fate of these compounds then depends on chemical structure and the media on which they settle.

SOIL CHEMICAL RESIDUE OFFSITE (System Stressor)
Depending on the stability of the class of pesticide used, accumulation of compounds in offsite soils may lead to continual, long-term impacts on wild species of plant and animal populations.

DECLINE IN TERRESTRIAL PLANTS (Ecological Effect)
A decline and alteration of wild species terrestrial plant populations can occur as a result of chemical residues in offsite soils from settling of aerosolized particles or from chemical leaching from onsite soils via runoff. Alterations in terrestrial plant populations may impact mammalian and avian wildlife through a decline in available vegetative food stuffs or a loss of appropriate nesting materials or habitat.

DECLINE IN UNTARGETED INSECT POPULATIONS (Ecological Effect)
In general, insecticides are broad-spectrum chemicals and impact both targeted and non-targeted insect species. Non-target species may be affected both onsite during proper application of chemicals and offsite as a result of drift and wind currents. Many insect species are critical to ecosystem functions, providing pollination for plant communities and food sources for avian and mammalian wildlife.

SOIL CHEMICAL RESIDUE ONSITE (System Stressor)
The fate of pesticides once they are applied depends on the intrinsic quality of the soil, the class of pesticide, and human activity factors. Pesticides may leave the site through several methods. Depending on the properties of the pesticide and the soil type there is the potential for some pesticide loss past the root zone. If this occurs, pesticides may leach into groundwater through percolation. Surface residues of the pesticide may be subject to direct runoff during application or after application via irrigation activities or natural weather conditions. In the case of pesticides tightly bound to surface soils, soil erosion can provide a mechanism for loss of pesticide mass via sediment. These two latter forms of run-off contribute to chemical loading in surface water bodies.

CHEMICAL LOADING OF GROUNDWATERS (System Stressor)
Groundwater may become contaminated as a result of percolation of pesticide in solution past the root zone and impact groundwater. EPA estimates that about 10 percent of the Nation's community water system wells and about 4 percent of the Nation's rural domestic wells contain at least one pesticide. However, no community water system wells and less than 1 percent of the rural domestic wells have pesticide levels exceeding EPA standards for drinking water (Source: USDA SCS 1992).

CHEMICAL LOADING OF SURFACE WATERS (System Stressor)
As noted above, pesticides can become loaded into surface water as a result of intrinsic soil and pesticide properties and from various application practices. Based on the chemical properties of the compounds, pesticides may be found in surface water in solution in the water column or bound to organic carbon in sediments. Sediments with high organic carbon levels will bind high levels of pesticides. Bound to sediments in this way, pesticides may be persistent in the environment and remain in the water body for extended periods. Pesticides in solution in the water column will be transported with the natural flow of the system and may leave the immediate environment but impact agricultural and natural ecosystems down stream.

UPTAKE BY BENTHIC ORGANISMS (System Stressor and Ecological Effect)
Benthic organisms, including shellfish, feed by filtering organic matter or sediments. In this way, these organisms can ingest pesticides. Ingested pesticides may have direct toxic effects resulting in die-off of the community or be taken up and accumulated in the tissues of these organisms. Many of these organisms provide a common food source for higher trophic levels in the food chain, including fish, terrestrial mammals, birds, and humans.

DECLINE IN FISH POPULATIONS (System Stressor and Ecological Effect)
Similar to the effects in benthic organisms, bottom-feeding fish may ingest sediment-bound pesticides. Other aquatic organisms, including shellfish are also affected. The effects may be direct toxicity or uptake and accumulation in fish tissues. Fish species feeding on benthic organisms that have ingested sediment-bound pesticides may suffer direct toxic effects or further accumulate and concentrate pesticides, with the potential to pass them on to higher trophic level species. Fish may also ingest suspended pesticides with direct toxic or tissue uptake results.

UPTAKE BY AQUATIC PLANTS (System Stressor)
The potential impacts of bound or suspended pesticides on aquatic plants are similar to those on benthic organisms. Pesticides may be directly toxic to plants or may be taken up by the plant and passed on to other members of the food chain.

DECLINE IN AQUATIC PLANTS (Ecological Effect)
Direct toxic effects in plants resulting in vegetation die-off directly impacts the organisms or species dependent on those plants for food or habitat, such as shellfish. Terrestrial mammalian and avian species feeding on aquatic plants that have taken up pesticides may be directly affected or in turn take up and concentrate the chemicals.

SURVIVAL OF TERRESTRIAL AND AVIAN WILDLIFE COMMUNITIES (Assessment Endpoint)
Terrestrial and avian wildlife communities are dependent upon quality water supplies. When pesticides are used irresponsibly or incorrectly, these communities may be directly affected by ingestion of contaminated water. In addition, the survival of Piscivorous terrestrial and avian wildlife is directly threatened by a decline, loss, or shift in fish populations. Through airborne drift of chemicals during application, non-target insect species may be impacted. Insects make up a large part of the diet of many terrestrial, avian, and fish species. Vegetation required by

wildlife species for food and/or cover are also adversely affected, as is the entire food chain. With the loss of food and cover, the availability of habitats declines, followed closely by a decline in the number of terrestrial and avian species.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Threatened and endangered species face the same risks from pesticide and chemical applications, as discussed in the previous paragraph on terrestrial and avian wildlife communities. The effects of this may be all the more dramatic, in that these species are already reduced in number. Any additional risk induced by stressors on their fragile habitats will serve to further reduce, perhaps to the point of extinction, their overall numbers.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
The additions of chemical compounds from pesticides, whether through direct application, spillage, through return flows in chemigation, or any other means will adversely affect the diversity of aquatic species. Those species that are highly intolerant to chemical compounds will disappear, which in turn will affect the viability of additional species. Food supplies and choice habitat areas will also be affected, either through die-off of the food or habitat source or the encroachment of more chemical tolerant species. Overall, the aquatic community will be changed. (See Irrigation Application and Soil/Land Disturbances Diagram, as well as the previous discussions on threatened and endangered species and terrestrial and avian species.)

POTABLE WATER SUPPLIES (Assessment Endpoint)
The addition of chemicals or chemical residues to surface and groundwater supplies can have detrimental effects to potable water supplies for humans and animals alike. Rural water supplies are still for the most part, dependent upon groundwater sources. Any infiltration of persistent chemical residues to these or surface water sources, could effect the potability of the supply, increasing the cost of treatment, if available at all. (For additional affects, see Irrigation Applications Diagram)

2.3.4 NUTRIENT AND ANIMAL WASTE APPLICATION

Agricultural land fertilization practices include the use of both commercially produced fertilizers, primarily nitrogen, phosphorus and potassium, as well as the utilization of animal waste products (manures, bedding, and composted dead animals). Inappropriate application of commercial and animal component fertilizers or the lack of sufficient land area on which to dispose of the nutrients derived from animal production, places various stressors on the environment. Also, plants can be damaged by excessive application of animal waste products through tissue sensitivity, toxicity, and tissue burning, resulting in decreased availability of agricultural products at the market.

Nutrients, including nitrates and phosphorus from agricultural and nonagricultural sources are the second leading cause of impairment in rivers, streams, lakes, and reservoirs and the primary

cause in estuaries, according to surface water assessments performed by the States in 1990 and 1991 (Source: NRCS, 1996).

2.3.4.1 ECOLOGICAL PORTRAIT

In many respects, the ecological assessment endpoints that are at risk from pesticides are at risk from nutrients; that is potable water supplies and aquatic, terrestrial and avian communities, including threatened and endangered species. Physically, the mechanisms by which nutrients, including those from animal manures, leave fields are similar to those of pesticides.

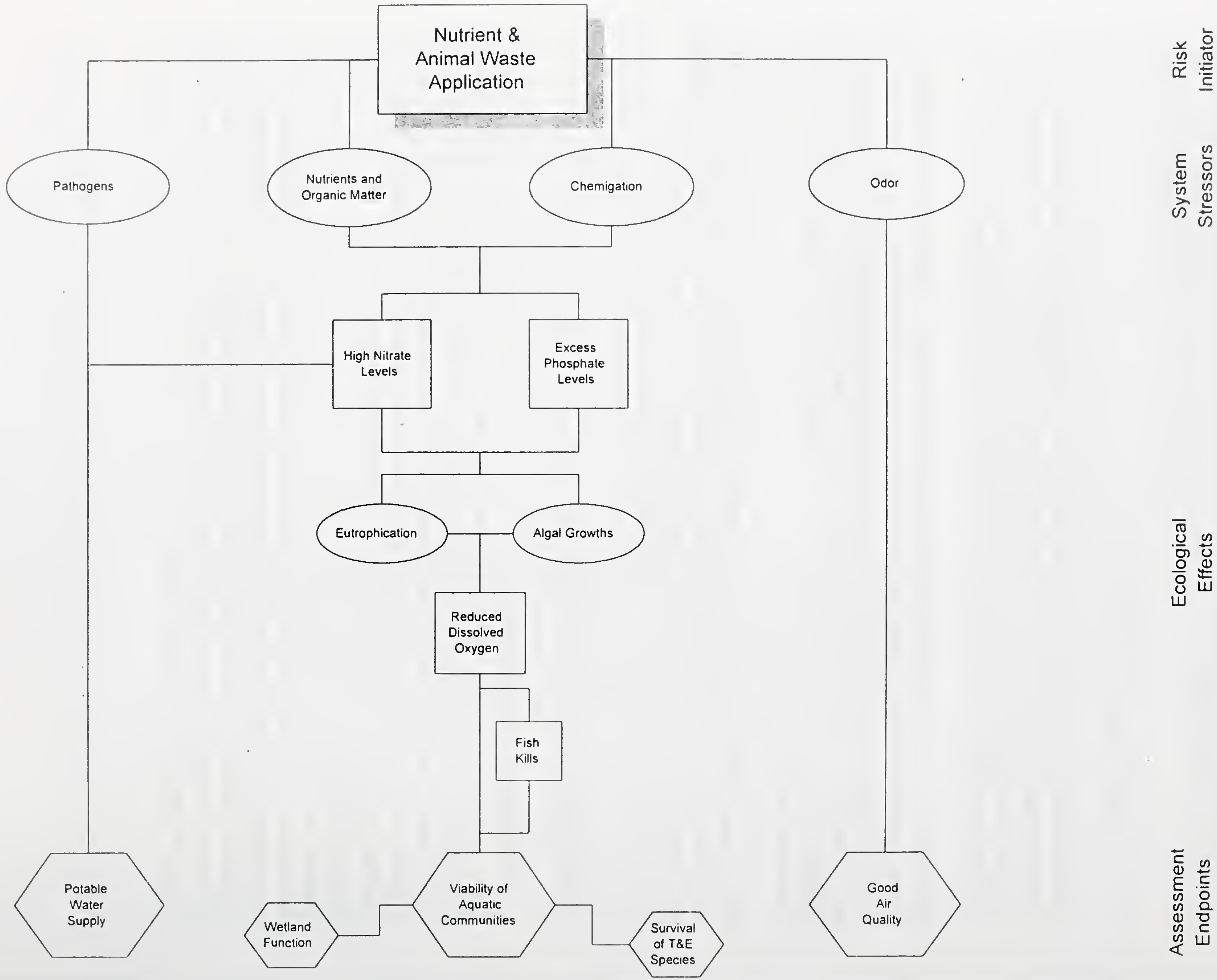
When nutrients, as nitrate and phosphates, leave fields via runoff to watercourses and water bodies, they can rapidly increase leading to algal growths and the rates of eutrophication and other deleterious effects. The resulting low levels of dissolved oxygen can lead to fish kills or damage to aquatic communities. Ecologically, all natural processes become accelerated, like a motion picture being shown at 200 frames per second instead of the usual 24 frames per second.

The ecological damage to potable water supplies, and aquatic communities, including wetlands and threatened and endangered species, can be catastrophic. Plants and animals can be displaced from normal niches and replaced by undesirable species. Many of the effects seen in the pesticide application discussion would be seen here for nutrient applications.

2.3.4.2 ECOLOGICAL DISCUSSION

PATHOGENS (System Stressor)
The excreta from warm-blooded animals have countless micro-organisms, including bacteria, viruses, parasites, and fungi. Some of the organisms are pathogenic (disease causing), and many of the diseases carried by animals are transmittable to humans, and vice versa. Human exposure to pathogens may occur as the result of direct contact with manure that is handled or spread on cropland, but it is more likely that exposure results from pathogens delivered to a water system as a result of runoff.

Pathogens account for impairments in approximately 60,000 stream miles, 0.64 million acres of water bodies, and 3,600 square miles of estuaries. Pathogens account for approximately 13 percent of the estuarine impairments nationwide. Pathogens are the main cause of impairment within the Southern Plains and Pacific States. The Northeastern States also include pathogens as a major source of estuarine impairments.


Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints
Nutrient & Animal Waste Application
Pathogens
Nutrients and Organic Matter
Chemigation
Odor
High Nitrate Levels
Excess Phosphate Levels
Eutrophication
Algal Growths
Reduced Dissolved Oxygen
Fish Kills
Potable Water Supply
Wetland Function
Viability of Aquatic Communities
Survival of T&E Species
Good Air Quality

NUTRIENTS AND ORGANIC MATTER (System Stressor)
The major nutrients that pose a risk to the environment are nitrogen and phosphorus, including the organic nitrogen and phosphorus from animal wastes. Nitrogen continually cycles among plants, soils, water, and the atmosphere, while phosphorus is less readily available due to adhesion to the clay particles of soil, moving into water bodies through sedimentation and siltation. According to the EPA, nutrients are the cause for impairments in more than 81,000 steam miles, 3.22 million acres of water bodies, and 4,751 square miles of estuaries. Nutrients are the priority concern within the Northeast and the Delta States. Approximately 18 percent of assessed estuaries were impaired by nutrients.

While nutrients affect the quality of both groundwater and surface water, organic matter contained in animal manure primarily affects surface waters. Organic matter, which is contained in large quantities in most types of animal manure, is delivered to surface waters either through direct spillage or through rainfall/runoff mechanisms. Once in the water body, the organic matter creates a demand for dissolved oxygen as part of the decomposition process. This results in less available dissolved oxygen for aquatic life, and in severe cases (high concentrations of organic matter), fish kills and death of other aquatic organisms. Catastrophic events, such as accidental spillage of large volumes, or failure of manure storage facilities may directly smother or suffocate organisms and have long-term negative effects.

CHEMIGATION (System Stressor)
Chemigation is the process of application of chemicals in an irrigation system and use of the irrigation system to convey the chemical to the crop. Fertigation, which is the application of fertilizer (nutrients) through use of the irrigation system is a subset of chemigation.

Theoretically, use of fertigation allows nutrients to be provided to the crop as needed, thereby reducing the potential for nutrients to be leached out of the crops root zone. However, situations may arise that would reduce the apparent application efficiency of the irrigation system. For example, a fertigation cycle may be necessary during a period when rainfall provides sufficient water to meet the evapotranspiration requirements of the crop. Thus, the irrigation system is operated solely to transport nutrients to the crop. If the soil is saturated or nearly so, there is increased potential for loss of nutrients. Once nutrients have been delivered to the cropland, the mechanism of transport and translocation is the same as for nutrients applied in a conventional manner.

HIGH NITRATE LEVELS (Ecological Effect)
Nitrogen, in various chemical compounds, is applied to cropland in the form of commercial fertilizer and manure, to promote the vigorous and healthy growth of plants. An essential plant nutrient, nitrogen continually cycles among plants, soil, water, and the atmosphere. Throughout this cycle, nitrogen undergoes complex biochemical transformations to nitrate, a water soluble form that is easily absorbed by plant roots. Excess nitrate can run off and leach through the soil, potentially polluting both ground-and surface waters. EPA has established a water quality standard of 10 mg/l of nitrate for drinking water. While this level is rarely exceeded in public water supplies on a large scale, there are locations around the country with large concentrations

of livestock and sensitive geologic formations, such as Karst (limestone) topography, that commonly do exceed this level.

EXCESS PHOSPHATE LEVEL (Ecological Effect)
Phosphorus is an essential element for plant growth and increased crop yields. However, because soil phosphorus is commonly immobilized in forms unavailable for crop uptake, phosphorus amendments, mineral fertilizer or animal manure, are needed to achieve desired crop yields. Despite its benefit to crop production, phosphorus becomes a pollutant when it enters surface water in substantial amounts (Source: NRCS, 1996).

Excessive phosphorus concentrations in surface water can accelerate eutrophication, resulting in increased growth of undesirable algae and aquatic weeds. This growth can impair water use for industry, recreation, drinking, and fisheries. Although nitrogen and carbon are also associated with accelerated eutrophication, most attention has focused on phosphorus as the limiting element. Because it is difficult to control the exchange of nitrogen and carbon between the atmosphere and a water body and because of the fixation of atmospheric nitrogen by some blue-green algae, phosphorus control is seen as the primary way to reduce the accelerated eutrophication of surface water. Because phosphorus is not as soluble as nitrogen, it is less a problem to groundwater (Source: NRCS, 1996).

EUTROPHICATION (System Stressor)
Water bodies need a certain amount of nutrients and minerals to support aquatic organisms. However, excess nutrients can result in an oxygen-deficient situation commonly known as eutrophication. Excess levels of nitrates in surface waters contribute to eutrophication and excessive growth of aquatic plants, leading to secondary effects, such as odor and a reduction in dissolved oxygen for fish and other aquatic organisms. Excessive contributions of phosphorus in surface water accelerates the eutrophication process. Phosphorus from animal manures can be significant, especially in regions with large, confined animal operations. This is due in part to the practice of applying animal manures based on nitrogen management and crop nitrogen requirements instead of soil phosphorus.

ALGAL GROWTH (System Stressor and Ecological Effect)
Growth of algae is stimulated by the addition of excess nutrients, particularly nitrogen and phosphorus, to surface waters. When phosphorus enters the freshwater environment, it can produce nuisance growths of algae and aquatic weeds and can accelerate the aging process in lakes. Direct toxicity to fish and other aquatic organisms is not a major concern, however fishkills and reduced fish populations can be related to resulting reduced levels of dissolved oxygen in the water. Dissolved oxygen levels are reduced as oxygen becomes used for the decomposition processing of the excess biomass (algae and other aquatic plants) that was stimulated by the excess nutrients. Algae may have impacts on water temperature (generally warming), thereby changing the make up of the aquatic community.

REDUCED DISSOLVED OXYGEN (Ecological Effect)
Reduced oxygen levels result from excessive oxygen demand for the decomposition of organic matter contained in the water body. Organic matter reaches a water body in several different ways. Generally, resultant organic matter from agricultural operations reaches a stream or lake in one of two ways. First, there is direct delivery of organic matter contained in manure through rainfall/runoff processes. Second, organic matter may result from decaying aquatic plants, the growth of which was stimulated by delivery of excess nutrients, again through rainfall/runoff processes.

In a natural environment, the breakdown of organic matter is a function of complex, interrelated and mixed biological processes. The organisms principally responsible for the decomposition process are micro-organisms. If a large amount of organic matter, such as manure, is added to a water body, the micro-organism population begins to grow with the rate of growth expanding rapidly. Since each micro-organism extracts dissolved oxygen from the water to survive, the addition of waste and the subsequent rapid increase in the microbial population could result in a drastic reduction in dissolved oxygen in a stream or lake.

FISH KILLS (Ecological Effect)
An adequate supply of dissolved oxygen is essential for good fish production. Adding wastes to a stream can lower oxygen levels to an extent that fish and other aquatic life are forced to migrate from the polluted area or die for lack of oxygen.

ODOR (System Stressor)
While there are some odors produced as a result of commercial fertilizer application, these are minimal compared to odors resulting from application of manure. Livestock production related (manure application included) odors, like other non-toxic odors, are nuisance pollutants and are not regulated by Federal action. However, they have been the subject of an increasing number of State and local regulations. (Reg: Miner, 1980).

Historically, unpleasant odors were associated with disease, but no direct tie between odors and disease has been discovered, although frequently, unhealthy environments are odorous. Odors may affect well-being by eliciting unpleasant sensations or they may trigger physiological reactions, such as possibly harmful reflexes modifying olfactory function. Reports show that unpleasant odors can elicit nausea, vomiting, and headache; cause shallow breathing and coughing; upset sleep, stomach, and appetite; irritate eyes, nose, and throat; and disturb, annoy, and depress (National Academy of Sciences, 1979). These symptoms are difficult to verify and measure. However, as a result, property values are often decreased in areas subject to frequent odor invasion. Conflicts between livestock producers and the public, concerning odor complaints, are 1980).

GOOD AIR QUALITY (Assessment Endpoint)
Air quality may best be defined by first providing a definition of air pollution, which is the accumulation in the atmosphere of substances that, in sufficient concentrations, endanger human health or produce other measured effects on living matter and other materials. Air quality then

relates to the measurement and quantification of these pollutants. Good air quality would contain low levels or none of the measured pollutants. EPA has established thresholds for major types of pollutants, which include carbon monoxide, hydrocarbons, nitrogen oxides, particulates, sulfur dioxide, and photochemical oxidants.

Although it doesn't endanger human or ecological health, odors emanating from applied manure can be quite noxious and irritating. Agricultural operations contribute to a certain extent, to all of these types of pollutants and irritants, but are major contributors to three of them: 1) particulates, nitrogen oxides, hydrocarbon compounds and odor. Particulate contributions consist of soil particles from tillage and other farming operations, dust, animal dander, chemical particulates and crop and feed residue particles among others. 2) Nitrogen oxides result from production, application and utilization of commercial fertilizer and animal manure. The primary hydrocarbon contributed to the atmosphere by agricultural operations is methane gas. 3) Photochemical alteration of nitrogen oxides and methane has been linked to formation of ozone and, consequently, global warming.

POTABLE WATER SUPPLY (Assessment Endpoint)
The addition of fertilizer residues in the water supply, whether ground or surface water, can have detrimental effects on potable water supplies for humans and animals alike. Rural water supplies are, for the most part, dependent upon groundwater sources. Any infiltration of nitrates or phosphates to these water supply sources could affect the potability, increasing the cost of treatment, and even, if left undiscovered, be responsible for deaths in unborn or small children. (See Irrigation Applications and Pesticide Applications diagrams.) Pathogens, if present in animal waste, may end up in drinking water supplies posing risk to susceptible sub-populations, such as infants and young children, immunologically suppresses individuals, and the elderly.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
Much as with the additions of chemicals and salts, the addition of nitrogen and phosphorus fertilizers into aquatic communities can be detrimental to species diversity, as well as food supply and habitat quality. The addition of nitrates and phosphates can cause eutrophication, which in turn, will cause decreases in available oxygen. A depletion in oxygen can eventually result in fish kills, and in some extreme cases, an entire absence of life, such as in the hypoxic zones of the Chesapeake Bay and the Gulf of Mexico. (See Soil/Land Disturbances diagram, Irrigation Application and Pesticide Application diagrams.)

WETLANDS FUNCTION (Assessment Endpoint)
Wetlands function as a filter for many compounds. However, when excessive amounts of compounds are introduced into the wetland, vegetation changes can occur that will have adverse affects on wetland functions. The presence or absence of vegetation often provides or enhances wildlife habitat. Habitat impacts carry over to riparian ecosystems and affect small game, waterfowl, and other residents of these systems. (See Soil/Land Disturbances diagram)

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Changes in vegetation induced by the addition of nitrogen and phosphorus runoff often will cause a change in the species diversity of an area. The existence or absence of vegetation often

provides or enhances wildlife habitat. Overall effects are not limited to the kinds of vegetation able to support the threatened and endangered species, but also the amount and quality of water, itself, will be a limiting factor on the species using an area for habitat. (See Soil/Land Disturbances diagram)

2.3.5 BRUSH AND NOXIOUS WEED INVASION

Brush and noxious weeds can be either native or introduced species. These plants can have adverse effects on other plants and animals in the area where the brush and noxious weeds occur. The effects may be immediate toxicity or long-term ecological change or both, depending on the species of brush or weeds involved. In either case, current ecological status is changed and may be beneficial or detrimental to human activities. However, brush and noxious weed eradication have caused adverse effects that need to be addressed to sustain agricultural and natural production.

Brush and noxious weed invasions are natural components of succession, e.g. the orderly process of ecological community change. Succession results from a change in habitat and invasion of new or introduced species. These species may be either aquatic, for example watermilfoil (*Myriophyllum spicatum*) or terrestrial, i.e. multiflora rose (*Rosa multiflora)* or kudzu (*Pueraria montana*). Changes in the environment or habitat results in change of the plant cover that has adapted to the area, and vice versa. Changes in plant species may result from the continued adverse physical disturbance of desirable plants until ultimately death of the desirable species results. Also, disappearance of plant species may result from starvation following reduced photosynthesis, natural old age accompanied by lack of reproduction, or drought made more serious by a weakened root system (Source: Stoddard, 1975).

2.3.5.1 ECOLOGICAL PORTRAIT

Brush and noxious weed invasions have a two-pronged detrimental effect on both livestock yields natural habitats. Additionally, the impacts are insidious in their operation, with farmers and ranchers only seeing adverse situations after many years of slow change.

An immediate effect that keepers of livestock see and must be constantly vigilant against is the toxic effects on grazing animals from noxious weed consumption. Animals can eat the noxious weeds and be physically affected, either temporarily or for long periods, by the toxins present in the plants. However, ecologically as animals continue to graze and selectively choose the plants they prefer, leaving the ones they do not like or that are toxic, the rangelands become populated with undesirable species. The result is a rangeland of low quality for both the grazing animals and for habitat in general.

Brush invasions acts in a similar fashion, but toxicities do not have to be involved. Instead, brush tends to displace desired species and habitat. When particular species of brush invade an

area there is little room left for other species to occupy the area. Additionally, the invading species is often able to outcompete desired species for one of the available resources of water, nutrients, sunlight, and so forth, thereby being even better capable of occupying even more territory than might otherwise have happened.

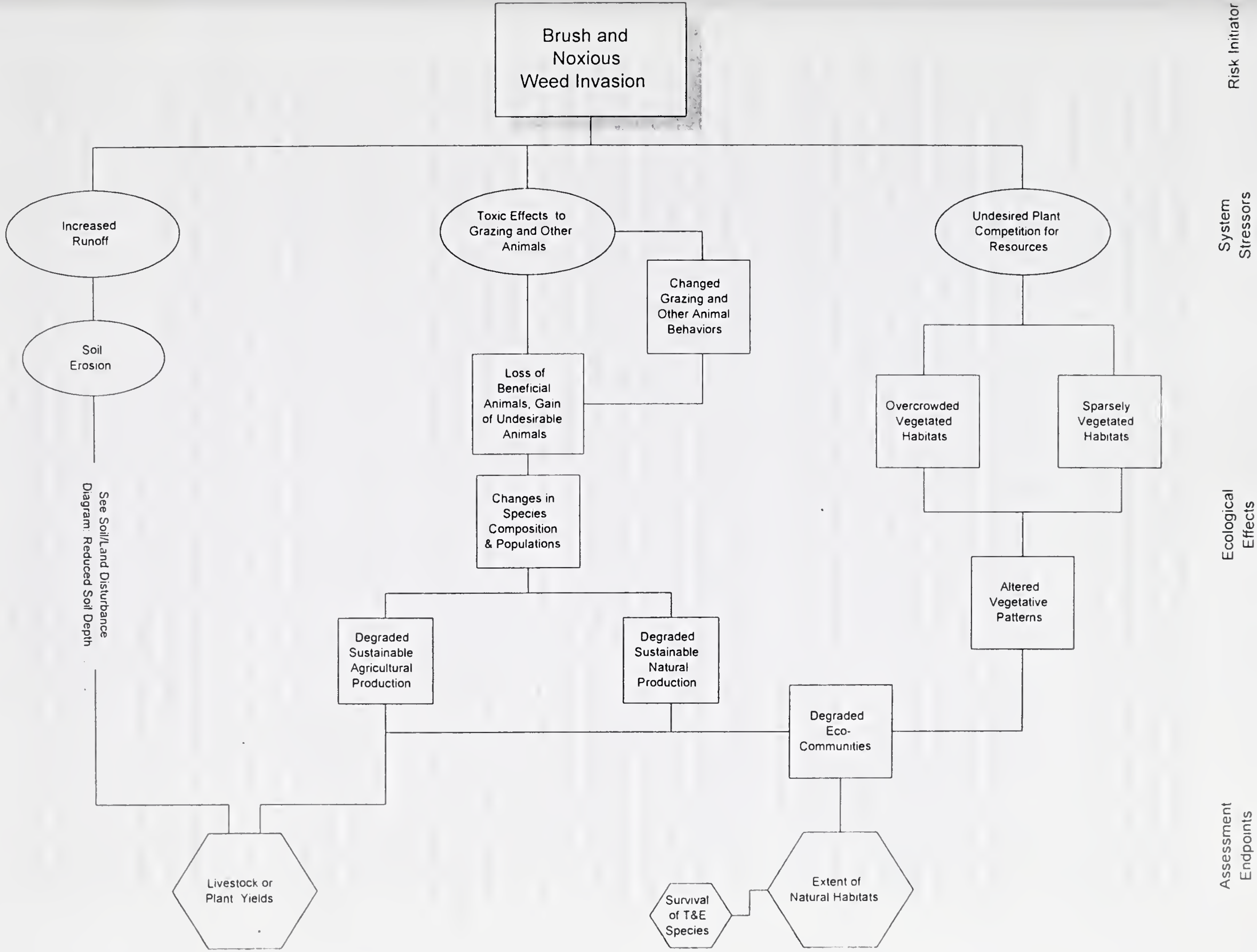
In the case of either toxic plant or brush invasion, grazing animals have a more difficult time of finding good forage materials to meet their needs. When this happens they must travel further distances for vegetation and water. This in turn requires the expenditure of more energy, and the need for additional forage. Also, with the extra expenditures of energy the animal can become weakened and more susceptible to diseases or will not be strong enough to tolerate the carrying, birthing or rearing of young. The result is lessened return for keepers of livestock because of the adverse grazing lands created by brush and energy the animal can become weakened and more susceptible to diseases or will not be strong enough to tolerate the carrying, birthing, or rearing of young. The result is lessened return for keepers of livestock because of the adverse grazing lands created by brush and noxious weeds.

The altered vegetative patterns also affect indigenous animals because their native habitat is changed both in physical appearance and in reduced capability to deliver nutrients and sustenance to the native animals. Thus, these animals move further from established areas to meet their bodily needs. Eventually, they may leave the area completely or because of reduced reproductive rates, are unable to sustain viable populations in the area. This situation may work against and be particularly devastating for the survival of threatened and endangered species. Even though these species may have marginally satisfactory reproductive rates under normal conditions and in a good habitat, when the habitat becomes dominated by invasive species that are heavily utilizing available resources, the threatened and endangered species are no longer able to compete and fall even further into decline.

2.3.5.2 ECOLOGICAL DISCUSSION

TOXIC EFFECTS TO GRAZING AND OTHER ANIMALS (System Stressor)
Toxic plants, either native or introduced, can effect livestock and other animals. These poisonous plants can be found in every region of the country. Many toxic plants are not harmful to livestock or other animals when consumed in small quantities, or they are harmful only during certain times of the year. The toxic effects on livestock and of animals from poisonous plants can range from diminished animal performance to actual death of the animal.

CHANGED GRAZING AND OTHER ANIMAL BEHAVIOR (Ecological Effect)
Changes in grazing animals' behavior from the effects of brush and noxious weeds takes two forms: 1) direct behavioral changes from toxicological effects on the animals; and 2) indirect behavioral changes because of the physical presence of the plants. Direct toxicological effects can alter behavior of grazing animals. These effects may be loss of appetite and cessation or reduction of food consumption, consumption of contaminated water when they otherwise would not have done so, unusual uncoordinated muscular movements making walking difficult or


Brush and Noxious Weed Invasion
Increased Runoff
Toxic Effects to Grazing and Other Animals
Undesired Plant Competition for Resources
Soil Erosion
Changed Grazing and Other Animal Behaviors
Loss of Beneficial Animals, Gain of Undesirable Animals
Overcrowded Vegetated Habitats
Sparsely Vegetated Habitats
Changes in Species Composition & Populations
Altered Vegetative Patterns
See Soil/Land Disturbance Diagram: Reduced Soil Depth
Degraded Sustainable Agricultural Production
Degraded Sustainable Natural Production
Degraded Eco-Communities
Livestock or Plant Yields
Survival of T&E Species
Extent of Natural Habitats
Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints

impossible, adverse effects on the sense of smell so hazardous plants or contamination are no longer avoided, or adverse effects on nerve functioning causing a lack of meaningful foraging, inattentiveness to rearing of young or other normal neurologically connected functionings.

LOSS OF BENEFICIAL ANIMALS; GAIN OF UNDESIRABLE ANIMALS (Ecological Effect)
As a result of adverse effects to grazing or other animals from the effects of brush or noxious weeds there can be the loss of beneficial animals by direct poisoning of animals, animal avoidance of affected areas or the removal or avoidance of an area because of management decisions. Animals here can include not only hoofed animals, but also macro-organisms that inhabit the soil, water, vegetation, and so forth, whose activities add to the total ecological health of the area. When one or more of these species become eliminated from the ecosystem, the ecosystem begins to fail in one aspect or another. When this happens, other more opportunistic, undesirable species can invade and take over the previously occupied ecological niche by displacing desirable species with undesirable species. The gain of undesirable species can and often will lead to a predominance of a single or relatively few species within an area.

CHANGES IN SPECIES COMPOSITION AND POPULATIONS (Ecological Effect)
Changes in species composition and populations are a continuing and dynamic process in nature. Areas are constantly changing in species composition, but normally the changes are within "standard" ranges where one species normally present in the area may predominate because of abundance or lack of water, nutrients, space, disease, air flow, and so forth However, at various times plant or animal species, previously unknown to the area may invade the area and begin to use the available resources. At this point, the species normally present will either be able to successfully compete for the resources with the new species or they will not. If the species that had normally been present for many years are not able to maintain their position to successfully compete with the invading species, then the invading species start to gain a foothold in the area and can eventually dominate, displacing one or more of the previous resident species. In this manner, the species composition and subsequently the populations of species change in the area concerned.

DEGRADED SUSTAINABLE AGRICULTURAL AND NATURAL PRODUCTION (Ecological Effect)
When the composition and populations of plant and animal species change, the ecology and sometimes the environment can become changed as well. The direction of that change has meaning to other plants and animals and to human endeavors within that area. Some plants and animals will benefit, while others will become adversely affected. The environment can become "degraded" as far as human activities are concerned; sustainable agriculture and/or natural production may be inhibited or restricted. Sustained farming efforts may become difficult-to-impossible or may cease altogether in these areas.

DEGRADED ECO-COMMUNITIES (Ecological Effect)
The accelerated succession of plants and animals as a result of human activities can degrade both aquatic and terrestrial ecosystems by accelerating natural resource losses, such as soil and water degradation. For example, increased soil erosion promotes nutrient loss from the soil, reduction

in soil depth, suspended sediments, nutrient loading to receiving waters, and increased air particulates. Increased nitrogen and phosphorus additions to watercourses and water bodies can accelerate eutrophication and loss of viable benthic and aquatic organisms. If management techniques are not utilized to restore the soil and water barren areas, suitable habitat for domestic or native wildlife will be lost.

UNDESIRED PLANT COMPETITION FOR RESOURCES (System Stressor)
As brush and noxious weeds begin to invade areas where more desirable plants are located, there occurs competition between these plant species for survival. In general, the best-adapted plant can compete best, because it can make most efficient and full use of the resources offered by the environment (Source: Stoddard, 1975). Brush and noxious weeds, unless managed properly, will outcompete the desired forage grasses. The first types of plant invaders are annuals, but later herbaceous or woody perennials of low grazing value can occur. Usually the largest plants that can thrive under existent soil moisture and climatic conditions will dominate. In most cases, the largest invasive perennials are brush and weeds.

OVERCROWDED OR SPARSELY VEGETATED HABITATS (Ecological Effect)
Succession of weeds and brush into the range environment may be slow, but they will be efficient in establishing and expanding their range by seed or by underground rhizome. The flora that they create generally will be the densest possible on the area forming a closed community in which soil and moisture resources are fully used and there is no room for additional plants. This does not mean the forage is dense. Dry areas may be fully occupied and still display bare surface soil which will be filled underground by roots. Bare ground should not be considered an indicator of unoccupied area or an ecologically open community (Source: Stoddard, 1975).

ALTERED VEGETATIVE PATTERNS (Ecological Effect)
The continued invasion of brush and weeds within areas of desired vegetation creates altered vegetative patterns. Natural succession occurs relatively slowly and involves a change in species composition and also a change in plant abundance. However, humans have radically changed rates of succession in plant communities in certain regions of the country by introducing new species of both plants and animals. Also, plant populations change under the reduced native animal impact and the increased grazing pressure of domestic animals. Plants that were most palatable to domestic livestock decline in vigor and abundance and became minor elements in the community. Less palatable plants increase. Entire plant communities change their composition and brush and woody plants increase on many rangelands.

DEGRADED ECO-COMMUNITIES (Ecological Effect)
The accelerated succession of plants as a result of human activities can degrade both aquatic and terrestrial ecosystems by promoting soil erosion through surface runoff and wind action. Increased soil erosion promotes nutrient loss from the soil, reduction in soil depth, suspended sediments, nutrient loading to receiving waters, and increased air particulates. If management techniques are not utilized to restore the habitat soil quality, deterioration occurs eventually leading to barren ground with no suitable habitat for domestic or native wildlife. There are exceptions to eco-community degradation in which certain conditions within the successional

process (where soil quality has not deteriorated completely) have actually improved some habitats for deer and other wildlife.

INCREASED RUNOFF (System Stressor)
Normally, soil is able to absorb excess storm water, but as a result of compaction this function is compromised. More water runs off the soil surface instead of entering the soil profile to be stored for plant use or in aquifers. Increased runoff can also augment nonpoint source pollution because water is rushing over the land accumulating soil particles, sediment, pesticides and nutrients. Increased runoff volume and energy from croplands disrupt water flow regimes, increasing discharge peaks and stream channel erosion. As a result of compaction the potential for flooding is increased.

EXTENT OF NATURAL HABITATS (Assessment Endpoint)
Habitat is the environment that allows plant and animal species to exist, survive, reproduce, and in general conduct normal biological functions to perpetuate the habitat's species. Habitats can change, either as a result of natural or human causes, and different spatial distributions and patterns of food and cover (shelter) result. These changes affect food and shelter availability causing an increase in resource competition between wildlife and/or domestic animals utilizing the remaining habitat to suit their continued needs.

Wildlife habitat may be significantly altered or destroyed. The disturbance can remove habitat and range, and reduce available food and water sources. This forces increased inter- and intra-species competition in areas where food, water, shelter, or nesting resources have been reduced or altered by the disturbance. Competition may ensue for any one of these resources or for all of them, depending on the level of disturbance and species requirements.

When habitat becomes altered through changed vegetative or animal patterns, the habitat is no longer capable of supporting the variety of species that previously had been there, or may become so dramatically changed that it can no longer support any species, even those that might have invaded to replace those that may have ceased to exist. At that point the habitat is degraded and is basically non-functional.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Increased competition and fewer resources can affect threatened and endangered species more than other species. Threatened and endangered species are less able to adapt to quickly-changing surroundings, as their habitat requirements are often more specialized than others. In addition, because these species have been identified as threatened and endangered, their populations are already depressed. Any further stress could be detrimental to species survival.

LIVESTOCK OR PLANT YIELDS (Assessment Endpoint)
Some runoff and erosion is natural, but accelerated erosion on degraded land reduces the land's production potential. Reduced soil depth inhibits plant growth, in turn, diminishing yields. The land may become too arid for the establishment of grasses or woody plants. Soil erosion can thus change the type and amount of vegetation the site can produce, perhaps even irreversibly.

Reduced soil productivity reduces both domestic and native plant yields, and that, in turn, reduces or impacts livestock growth.

2.3.6 PASTURE GRAZING

Pasture grazing is the consumption of native or introduced vegetation by livestock in an area devoted to the livestock production. Improper grazing results when grazing of livestock is done without proper attention to livestock stocking rates, vegetative stand composition, duration of grazing periods, amount of fertilization needed and appropriate weed control, resulting in degradation of the resource.

Livestock that are allowed access to streams, can trample streambanks causing erosion or direct contamination of water through animal waste deposition. Loosened silts and sediments can enter wetlands and riparian areas, where there can be adverse environmental effects to those areas. Nutrient and sediment loadings to streams are likely to occur with improper grazing management. Allowing animals to graze at inappropriate times of the year can cause excessive damage to plant cover, as well as allowing grazing animals on the same area for extended periods of time.

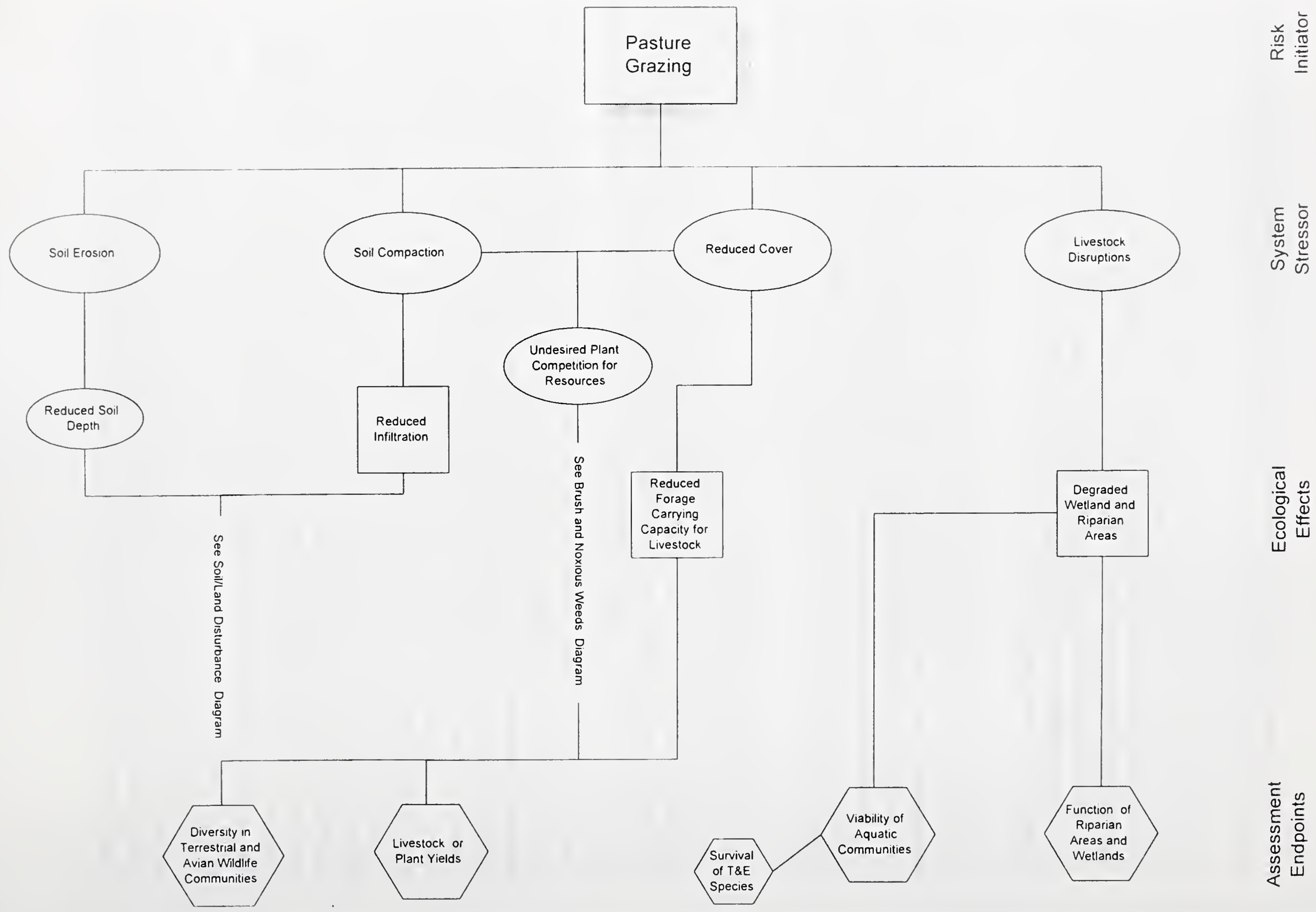
2.3.6.1 ECOLOGICAL PORTRAIT

While some similarities exist between rangelands and pasturelands as to the types of animals involved, the ecological stressors and effects are quite different. For ecological aspects, pasturelands are closer to croplands than to rangelands, and in effect what is being "grown" is a crop.

The familiar stressors of soil erosion, compaction, and reduced vegetative cover are the main disruptions to the areas involved. These stressors lead to reduced soil depth and reduced infiltration of water, reduced forage, and competition by undesired plant species for available resources. These actions adversely affect pasture animals leading to reduced animal weights and vigor. Animals can become more easily stressed and not gain acceptable amounts of weight to be ready for market.

Ecologically, a major disruption by livestock in pastureland situations is that of physical disturbances by the animals in riparian areas and wetlands. When they have access to these areas, the animals will make use of the areas for drinking water and to keep cool in the shade. Unfortunately, the elimination of their wastes directly into the watercourses and water bodies contaminates those aquatic areas, adding nutrients and accelerating algal growths and eutrophication.

Another major consequence of animals being allowed into streams is the trampling of streambanks and stream bottoms. An immediate consequence is the release of sediments to the watercourses with its attendant sedimentation and siltation problems. Also, the animals' hoof



Risk Initiator
System Stressor
Ecological Effects
Assessment Endpoints
Pasture Grazing
Soil Erosion
Soil Compaction
Reduced Cover
Livestock Disruptions
Undesired Plant Competition for Resources
Reduced Soil Depth
Reduced Infiltration
Reduced Forage Carrying Capacity for Livestock
Degraded Wetland and Riparian Areas
See Soil/Land Disturbance Diagram
See Brush and Noxious Weeds Diagram
Diversity in Terrestrial and Avian Wildlife Communities
Livestock or Plant Yields
Survival of T&E Species
Viability of Aquatic Communities
Function of Riparian Areas and Wetlands

actions break the bottom's stability that has been built over time and destroys the benthic community, both directly and then downstream where sediments settle and cover active benthic communities there. The adverse ecological effects on threatened and endangered species are multiplied, especially when considered in the context of wetlands and riparian areas where many of these species reside or have part of their life cycle.

2.3.6.2 ECOLOGICAL DISCUSSION

REDUCED VEGETATIVE COVER (System Stressor)
Vegetative cover is the most important component of pastures. The maintenance and perpetuation of that cover is the overriding factor to concerned with pasture management. The vegetative cover can become overgrazed to the extent that inadequate amounts of vegetative residue are left to provide adequate soil protection. This condition accelerates erosion and reduces economic returns.

REDUCED FORAGE CARRYING CAPACITY FOR LIVESTOCK (Ecological Effect)
The carrying capacity of pastures can become reduced, creating a condition where the pasture is unable to provide sustainable forage for an appropriate number of animals. Further grazing causes degradation of the resource to the point that it becomes difficult to return the resource to a productive mode or productivity can only be returned with great amount of energy and inputs. Carrying capacity is expressed in animal unit months, which is defined as the monthly food needs for the equivalent of a one-thousand-pound beef cow.

SOIL COMPACTION (System Stressor)
The compaction of soils is a process by which the soil grains are rearranged, decreasing their void space and bringing them into closer contact with one another. Compaction can result from a combination of insufficient ground cover and excessive animal or vehicular traffic over soil surfaces. On certain soils, hoof action from livestock grazing in areas with thin cover or bare areas can cause compaction of the soil. Compaction impedes infiltration and percolation of water through the soil.

REDUCTION OF DESIRED PLANT SPECIES (Ecological Effect)
The result of grazing excessive numbers of animals on the same area for extended periods is a reduction in the numbers and kinds of desired plant species. Continuous heavy grazing pressure results in over consumption of the most desirable plants causing their decline in the stand, i.e. degradation of stand composition. Weeds and less palatable plant species eventually dominate the stand.

INCREASED RUNOFF (Ecological Effect)
See Soil/Land Disturbances-Compaction. Increased runoff of water, caused by livestock grazing, occurs when one or more of the following conditions are present: reduced vegetative cover to intercept raindrops, crusting of soils by impact of raindrops on bare areas, that cause puddling, or compaction that reduces water infiltration.

REDUCED INFILTRATION (Ecological Effect)
See Soil/Land Disturbances-Compaction. Reduced infiltration, caused by grazing animals, is a result of reduced cover and hoof action that compacts the soil. Compacted soil slows or prevents the infiltration of water into the soil resulting in increased runoff.

DIVERSITY IN TERRESTRIAL AND AVIAN WILDLIFE COMMUNITIES (Assessment Endpoint)
Impaired wildlife habitat may be the result of overgrazing available forage, by reducing cover, species diversity, and food necessary to sustain wildlife populations. Improper grazing management also contributes to reduced water quality that negatively impacts fisheries and other aquatic resources.

LIVESTOCK DISRUPTIONS (System Stressor)
Livestock disruptions to riparian areas result when domestic animals are permitted to occupy riparian areas. Animals, if permitted, will seek riparian areas for cooling shade, drinking water, or relief from climatic elements in general. Soil disturbance occurs on streambanks and adjacent lands causing accelerated erosion and sedimentation. Animal traffic in the streambed causes disturbance of aquatic habitats and communities. Animal waste is deposited directly into the stream, degrading water quality. Nesting habitat in riparian areas is adversely affected.

DEGRADED WETLANDS AND RIPARIAN AREAS (Ecological Effect)
Wetlands and riparian areas are ecologically connected resources that are subject to damage by livestock. Riparian areas are those areas on or immediately adjacent to the banks of a natural watercourse. Wetlands are areas that are seasonally flooded or where the water table is usually at or near the surface and that has one or more of the following: hydric soils, capable of supporting hydrophytic plants, or covered by shallow water at some time during the growing season of the year. Wetlands function like natural "sponges," storing excess water and releasing it slowly. This reduces the likelihood of flood damage by reducing the frequencies and magnitude of flood flows. Wetlands also reduce water's erosive potential. Like a filter, wetlands trap nutrients, sediment, and waste materials and prevent them from entering water bodies. These wetland functions are degraded as they are filled with sediment and the assimilative capacity is reduced.

Degraded riparian areas are the result of reduced vegetative cover and erosion on streambanks caused, in part, by overgrazing and livestock traffic on the banks. Wildlife suffers due to loss of habitat and nesting disturbances. Impaired water quality also results from animal waste deposited in the stream.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
Loss of aquatic plants due to sediment, siltation, and shading, affects the entire ecosystem. The fish populations dependent on these food and habitat sources may decline, resulting in reduced food sources for higher trophic level piscivorous avian and mammalian species. Unmanaged grazing also impacts the types of vegetation available. Overstory vegetation can be damaged or destroyed by unmanaged cattle grazing. This results in a loss of shading, that leads to increased surface water temperatures, resulting in changes in aquatic species composition.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Increased competition and fewer resources may affect threatened and endangered species more than other species. Threatened and endangered species are less able to adapt to quickly-changing surroundings, as their habitat requirements are often more specialized than other species. In addition, because these species have been identified as threatened and endangered, their populations are already depressed. Any further stress could be detrimental to species survival.

FUNCTION OF RIPARIAN AREAS AND WETLANDS (Assessment Endpoint)
Wetlands function like natural sponges storing water and slowly releasing it. This reduces the likelihood of flood damage, prevents certain floods, and reduces flood heights. Wetlands also reduce water's erosive potential. Working like a filter, wetlands trap nutrients, sediments, and other materials from entering water bodies. As wetlands are filled with eroded soil, these functions are degraded. Although this is a natural process, it can be accelerated by farming activities. Riparian areas, when functioning properly, help to abate flooding damages. Uncontrolled grazing by livestock in riparian areas can adversely affect the sinuosity of the channel, causing impacts to the entire riparian area. Degraded riparian areas are the result of reduced vegetative cover and erosion on streambanks caused by overgrazing and livestock traffic on the banks. Wildlife suffers due to loss of habitat and nesting disturbances. Impaired water quality also results from animal waste deposited in the stream.

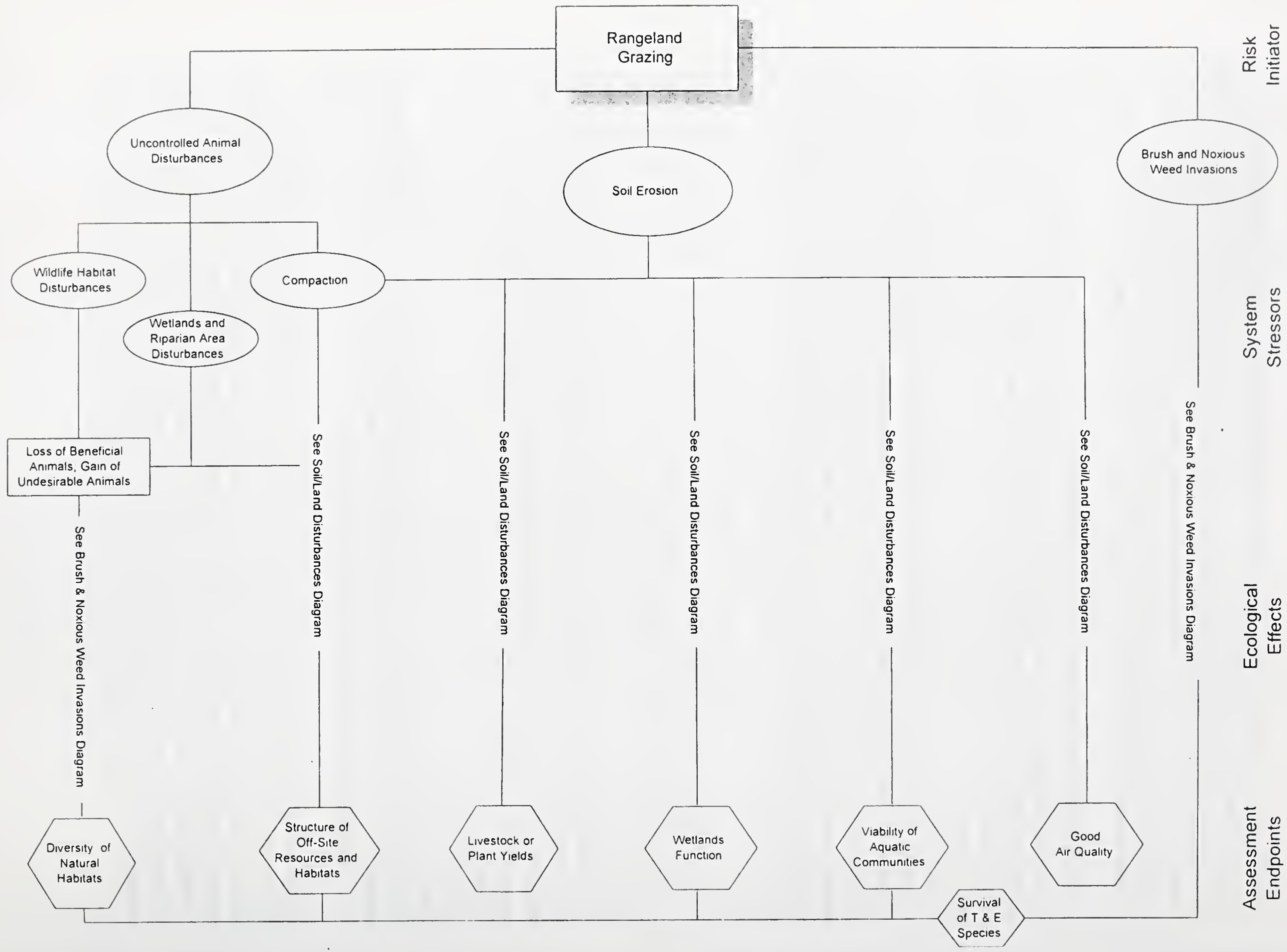
2.3.7 RANGELAND GRAZING

2.3.7.1 ECOLOGICAL PORTRAIT

Rangeland represents approximately 47 percent of the earth's surface. (L.A. Stoddart, Smith. and Box, 1975). The U.S. has a total of about 770 million acres of rangeland, with 57 percent or 398 million acres, being non-Federal lands. Rangelands are defined as: land on which the native vegetation is predominately grasses, grass-likes, forbs, or shrubs suitable for grazing or browsing.

Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows. Rangelands can be found from the freshwater marshes and savanna flatwoods of Florida, to the mountain meadows of Utah, to the hot deserts of California (Source: Rangeland Health, NRC, 1994).

Rangeland plant communities have evolved to survive their naturally harsh environmental conditions. These ecosystems are adapted to such limitations as short growing seasons, shallow soils, low annual rainfall, steep topography, low soil nutrients, saline conditions, and extreme temperatures, both high and low. Natural stressors to rangelands include periodic drought, flooding, insect eradication, burning, and herbivory. Rangelands have evolved with these natural stressors, and in many instances such as periodic fire and herbivory, depend upon them periodically to maintain a healthy viable ecology.



Rangeland Grazing
Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints
Uncontrolled Animal Disturbances
Soil Erosion
Brush and Noxious Weed Invasions
Wildlife Habitat Disturbances
Compaction
Wetlands and Riparian Area Disturbances
Loss of Beneficial Animals, Gain of Undesirable Animals
See Brush & Noxious Weed Invasions Diagram
See Soil/Land Disturbances Diagram
See Soil/Land Disturbances Diagram
See Soil/Land Disturbances Diagram
See Soil/Land Disturbances Diagram
See Soil/Land Disturbances Diagram
See Brush & Noxious Weed Invasions Diagram
Diversity of Natural Habitats
Structure of Off-Site Resources and Habitats
Livestock or Plant Yields
Wetlands Function
Viability of Aquatic Communities
Good Air Quality
Survival of T & E Species

Human-induced stressors such as grazing livestock at inappropriate seasons, durations, and concentrations or kinds of animals can stress rangelands beyond their natural recovery mechanisms. When this occurs, rangelands tend to be degraded ecologically causing diminished values and benefits to society. The three primary stressors on rangelands are: animal impacts; weed and brush eradication; and soil erosion and permanent changes to rangeland ecology. Prior to soil loss on rangelands, if the natural vegetation has not been totally removed or destroyed, management applications can often be applied to reverse this downward trend in rangeland health. Whether this is economically feasible can only be determined on a case-by-case basis, especially on the private rangelands that make up the majority of this land use. Cash flow, commodity programs, and commodity prices directly influence the type and level of management on private rangeland.

2.3.7.2 ECOLOGICAL DISCUSSION

UNCONTROLLED ANIMAL DISTURBANCES (System Stressor)
Uncontrolled animal grazing activity on rangelands is the principal mechanism that causes rangeland degradation. These impacts can be caused by both wildlife and domestic livestock. Animal removal of rangeland herbage beyond the ecosystems ability to recover from the perturbation initiates a series of problems that, if left unchecked, will unravel the entire ecosystem.

As uncontrolled grazing persists, plant species composition is altered and ultimately biodiversity of flora and fauna is reduced. With repeated hoof actions of animals, soils can become compacted and water infiltration reduced on these sites. As the plant composition continues to change over time, the structure of the rangeland is changed from an open predominately shortgrass prairie to an enclosed shrubby sagebrush community. Animal waste and nutrients impact surface waters, both onsite and offsite. These changes adversely affect not only the rangeland's ability to produce herbage for livestock, but also affects the wildlife habitat, groundwater recharge, and watershed functions.

BRUSH AND NOXIOUS WEED INVASIONS (System Stressor)
Increases in weed or brush establishment, non-native invasive plants, and toxic plants available to livestock and wildlife can have a significant impact on the viability of range or grazing lands for cattle, as well as on habitats for non-domestic species.

When desirable native rangeland vegetation is continually damaged by uncontrolled herbivory, these plant species lose vigor and are replaced with species of lesser value to the animals present. Weed and brush species, that were not present on the site or present only in small amounts, become prominent. These weed and brush species are not affected by the current animal impacts due to their unpalatability or other physical protection from the grazing animals, that are causing the damage.

In some instances, non-native invasive plants gain a foothold into native rangeland ecosystems. Species such as leafy spurge, spotted knapweed, and cogongrass can literally takeover rangelands

where conditions are suitable for these exotic species, these undesirable species can totally disrupt the ecological functions and values of the sites. Another effect from uncontrolled grazing is the increased presence of plants, that are toxic to both wildlife and livestock. Typically, animals are not poisoned by toxic plants common to their environment, due to an abundance of forage plants and their low levels of intake of the toxic species. However, the preferred vegetation is diminished and repeated intake of toxic plants is increased as desired species is decreased.

SOIL EROSION (System Stressor)
Soil erosion can be viewed as both a stressor and as an ecological response to a stressor. For the purposes of this analysis, it is being shown as a stressor to show the effects to the environment that occurs from improper grazing management. Under natural conditions with very few exceptions, rangelands provide a stable environment for the soil. At a high level of health and condition, rangelands are highly functional ecosystems providing ideal environments for the distribution of nutrient cycling and energy flow. Distribution of photosynthesis, plant biomass above and below ground, plant age-classes, and litter incorporation back to the soil profile ensure a sustainable system.

Natural recovery mechanisms are in place on rangelands that are capable of withstanding natural stressors as well as human stressors. When these stressors exceed the rangeland`s ability to recover, soil loss occurs from water and/or wind. If these conditions are maintained long enough, the rangeland ecosystem is permanently changed and the natural values diminished.

WILDLIFE HABITAT DISTURBANCES (System Stressor)
Habitat is the environment that allows plant and animal species to exist, survive, reproduce, and in general, conduct normal biological functions to perpetuate the habitat's species. Habitats can change, either as a result of natural or human causes, resulting in different spatial distributions and patterns of food and cover (shelter). These changes affect food and shelter availability, causing an increase in resource competition between wildlife and/or domestic animals utilizing the remaining habitat to suit their continued needs.

Wildlife habitat may be significantly altered or destroyed. The disturbance can remove habitat and range, and reduce available food and water sources. This forces increased inter- and intra-species competition in areas where food, water, shelter, or nesting resources have been reduced or altered by the disturbance. Competition may ensue for any one of these resources or for all of them, depending on the level of disturbance and species requirements.

WETLAND AND RIPARIAN AREA DISTURBANCES (System Stressor)
Wetlands function like natural sponges storing water and slowly releasing it. This reduces the likelihood of flood damage, prevents certain floods, and reduces flood heights. Wetlands also reduce water's erosive potential. Working like a filter, wetlands trap nutrients, sediments, and other materials from entering water bodies. As wetlands are filled with eroded soil, these functions are degraded. Although this is a natural process, it can be accelerated by farming activities. Riparian areas, when functioning properly, help to abate flooding damages. Uncontrolled pasture grazing of livestock in riparian areas can adversely affect the sinuosity of

the channel, that will then cause impacts to the entire riparian area. Degraded riparian areas are the result of reduced vegetative cover and erosion on streambanks caused by overgrazing and livestock traffic on the banks. Wildlife suffers due to loss of habitat and nesting disturbances. Impaired water quality also results from animal waste deposited in the stream.

SOIL COMPACTION (System Stressor)
When soil becomes compacted, aeration of the soil to promote plant growth is inhibited and the soil becomes a hard surface that runoff waters can easily speed over, leaving the land drier with receiving waters getting many of the nutrients that were intended for cultivated crops. As a result the land gets less of what it needs to produce good crops, and receiving waters get more of what they don't need, mainly nutrients that promote excessive aquatic plant growth.

Soil compaction has consequences on the plants themselves. Compaction, in addition to leading to increased runoff, decreases the moisture available to plants and reduces the area into which plant roots can expand. This condition, tied to the ones above, stunts plant growth even further and reduces plant productivity. With plant growth reduced, adverse effects are transferred to the livestock and other animals that depend on those plants for their sustenance.

SOIL EROSION (System Stressor)
Although erosion is a natural geologic process, it is often accelerated by cultivation and resource development. Soils are living, dynamic systems that are altered by changes in water content, temperature, and human activities. Following a disturbance, erosion can result in a variety of forms - gully, sheet, or rill - each having distinctive effects. Soil erosion can have effects on-farm or offsite. In general, erosion from fields used for crop, pasture, or forest production means there is less high quality soil remaining for future production. Onsite erosion damage can reduce the productivity of land, labor and capital, and increase the need for inputs, such as fertilizer. Erosion degrades soil conditions by lowering organic-matter content, decreasing rooting depth, and decreasing available water capacity.

LIVESTOCK OR PLANT YIELDS (Assessment Endpoint)
Some runoff and erosion is natural, but accelerated erosion reduces the land's production potential. Reduced soil depth inhibits plant growth, diminishing yields. The land may become too arid for the establishment of grasses or woody plants. Soil erosion can thus change the kind and amount of vegetation the site can produce, perhaps even irreversibly. With vegetation changes, the ability of the land to support livestock or plants is severely impacted.

DIVERSITY OF NATURAL HABITATS (Assessment Endpoint)
Wildlife habitat, including wetlands and riparian areas, may be significantly altered or destroyed. The disturbance can remove habitat and range, and reduce available food and water sources. This forces increased inter- and intra-species competition in areas where food, water, shelter, or nesting resources have been reduced or altered by the disturbance. As the habitat diversity is altered, competition may ensue for any one of these resources, or for all of them, depending on the level of disturbance and species requirements.

WETLANDS FUNCTION (Assessment Endpoint)
Wetlands function like natural sponges storing water and slowly releasing it. This reduces the likelihood of flood damage, prevents certain floods, and reduces flood heights. Wetlands also reduce water's erosive potential. Working like a filter, wetlands trap nutrients, sediments, and other materials from entering water bodies. As wetlands are filled with eroded soil, these functions are degraded. Cattle grazing or loafing in wetland and riparian areas can irreversably alter the ability of a wetland to function.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
Loss of aquatic plants due to sediment, siltation, and shading, affects the entire ecosystem. The fish populations dependent on these food and habitat sources may decline, resulting in reduced food sources for higher trophic level piscivorous avian and mammalian species. Pathogens, introduced into water through animal wastes, can be especially detrimental to some aquatic species.

SURVIVAL OF THREATENED AND ENDANGERED SPECIES (Assessment Endpoint)
Increased competition and fewer resources may affect threatened and endangered species more than other species. Threatened and endangered species are less able to adapt to quickly-changing surroundings, as their habitat requirements are often more specialized than other species. In addition, because these species have been identified as threatened and endangered, their populations are already depressed. Any further stress could be detrimental to species survival.

GOOD AIR QUALITY (Assessment Endpoint)
Overgrazing and cattle hoof action can have damaging impacts upon the fragile rangeland soil resources. Increased exposure of these resources to the effects of high, sustained winds will accelerate impacts from wind erosion, resulting in additional dust particulates. Air quality is then subject to significant degradation.

STRUCTURE OF OFFSITE RESOURCES AND HABITATS (Assessment Endpoint)
Poor rangeland management significantly impacts offsite resources by reducing the amount and kinds of plant cover available. As the plant species change, other adverse impacts begin to have effects, such as more accelerated soil erosion. Potential offsite impacts may extend from the exacerbation of an expected or unexpected flood event. Normally dry habitat may become impounded with water, disturbing the ecosystem community. Flood events can also upset aquatic habitats due to increased turbidity, temperature changes, and sedimentation. Such an event could be devastating to particular species, thus altering the ecosystem. Increased flood events, such as have been experienced in the Midwest, have devastating effects upon human health, safety, and welfare. Many millions of dollars in damages to land, buildings, equipment, livestock, and crops were realized.

2.3.8 CONFINED LIVESTOCK PRODUCTION

Confined livestock production may be defined as the process of raising livestock in limited areas. Confinement may take place in a building, such as a swine or poultry house, or it may be a fenced outdoor feedlot that frequently is used for production of beef cattle. Generally, large numbers of animals are contained in relatively small areas. These types of livestock production, which may also be referred to as concentrated feeding operations, present problems that do not normally occur when animals are raised in an open space or range.

Since the demand for animal feed with these types of operations is great, in most cases all the required feed cannot be grown on the farm where livestock production occurs. Therefore, much of the feed is grown elsewhere, frequently considerable distances away, which is then transported to the livestock production facility. This results in an energy imbalance in the form of accumulated waste and other byproducts of the operation, all of that must be utilized or disposed. As such, these operations place a strain on the local ecosystems. Concentrations of large numbers of animals may result in air and water quality problems.

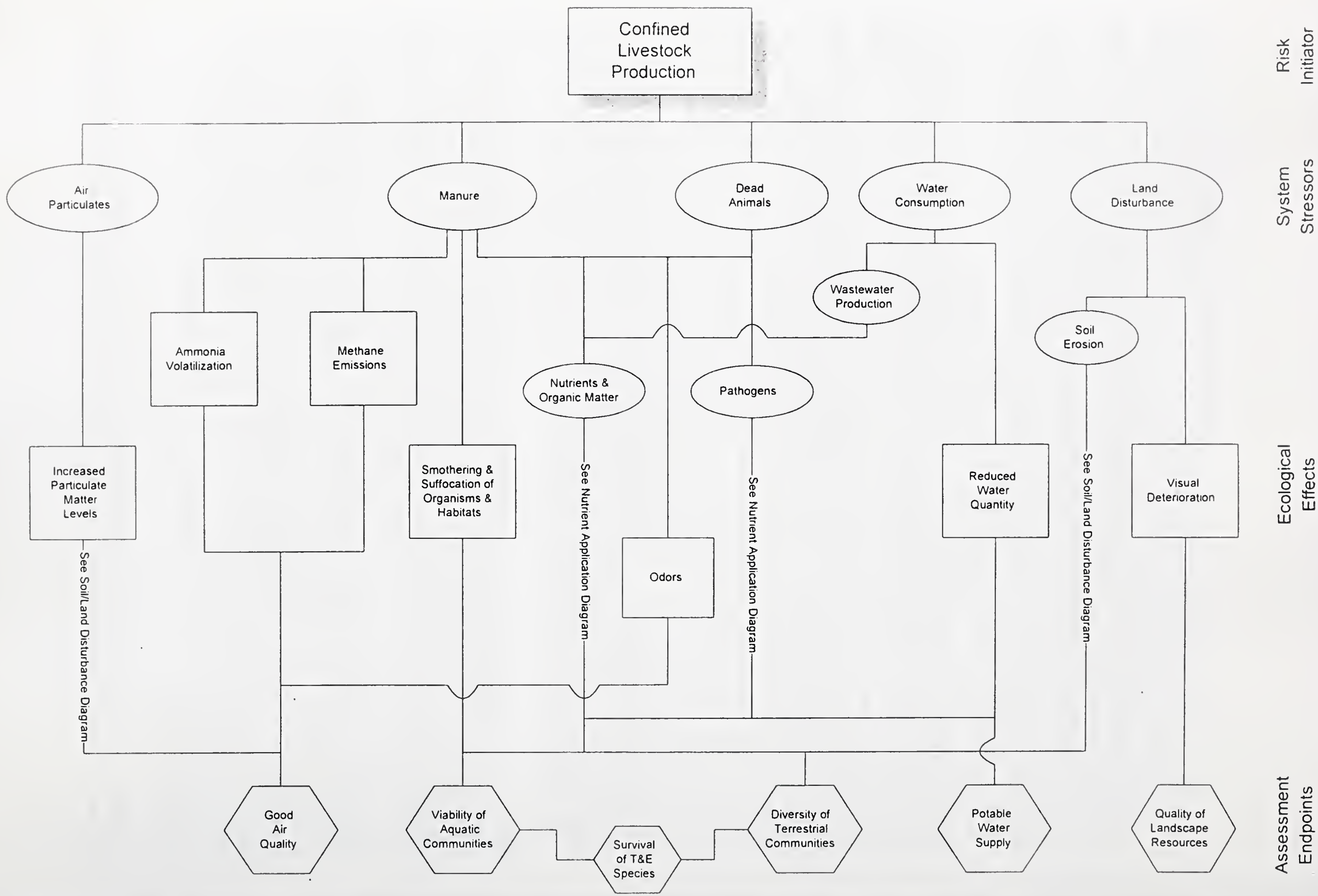
2.3.8.1 ECOLOGICAL PORTRAIT

Confined livestock production should theoretically be one of the most efficient, least environmentally harmful ways to grow animals for the market. Instead, what can happen is a situation where nearby environments and ecology can be degraded and public outcry against these facilities can reach a crescendo. Environmental stressors extend over all resources of soil, water, plants, animals, air, and human resources.

Manure, dead animal disposal, water consumption and contamination, land disturbance, and air quality can be threatened by large confined livestock operations. Ammonia and methane and other gas, many with obnoxious odor production with decaying organic matter can yield offensive odors that may force neighbors to permanently leave the area. Often, visual resources are impaired that add to the flight or the difficulty to get people to move into the area.

Ecologically, especially when the waste products of the animals are not properly or adequately cared for, offsite effects can be detrimental by reducing water quality, reducing available water supplies, smothering local organisms and habitats, and generally adversely affecting aquatic communities. More than 5,000 years, ago inhabitants of several cultures decided to start agricultural efforts to improve their chances of survival by increasing their ability to compete over adjacent cultures. It succeeded, in part because land was available upon which the by-products of agriculture could be assimilated, treated, and disposed at no extra burden on the farmers or to nature.

In taking livestock production one step further with confined facilities, producers are attempting to make a high-volume factory out of scarce resources. However, the extra amounts of land that



Confined Livestock Production
Risk Initiator
System Stressors
Ecological Effects
Assessment Endpoints
Air Particulates
Manure
Dead Animals
Water Consumption
Land Disturbance
Wastewater Production
Soil Erosion
Ammonia Volatilization
Methane Emissions
Nutrients & Organic Matter
Pathogens
Increased Particulate Matter Levels
Smothering & Suffocation of Organisms & Habitats
Odors
Reduced Water Quantity
Visual Deterioration
See Soil/Land Disturbance Diagram
See Nutrient Application Diagram
See Nutrient Application Diagram
See Soil/Land Disturbance Diagram
Good Air Quality
Viability of Aquatic Communities
Survival of T&E Species
Diversity of Terrestrial Communities
Potable Water Supply
Quality of Landscape Resources

previously acted to assimilate the by-products of that production are not available. In fact, that is part of the economic equation; how to keep land acreages and costs to a minimum. That means that the costs to treat the animal by-products must be internalized, the costs might be borne by the consumer of the products, or the costs of treatment must be externalized. Unfortunately, wastes and by-products are sometimes or too often mishandled or mismanaged while ecological resources are further degraded in an attempt to create a viable operation.

2.3.8.2 ECOLOGICAL DISCUSSION

AIR PARTICULATES (System Stressor)
Particulate matter (PM) represents a broad class of substances that occur throughout the atmosphere, originate from a variety of sources, and have different effects on human health and the environment as well as different chemical and physical properties. The common feature of PM is its existence as discrete particles rather than as gases. Some particles are liquid, some are solid, and others contain a solid core surrounded by liquid. The PM in the air contains inorganic compounds, elemental carbon, organic compounds, and crustal compounds (Source: STAPPA/ALAPCO, 1996).

Particulate matter has been associated with adverse effects on human health for many decades. Studies available today indicate that the major risks of particulate matter to human health include not only premature mortality from acute pollution episodes, but also increased morbidity from aggravation of existing respiratory and cardiovascular disease, damage to lung tissue, impaired breathing and respiratory symptoms, and alterations to the body's physical and immune system defenses against inhaled particles (Source: STAPPA/ALAPCO, 1996).

Particulate matter resulting from confined livestock production includes dust from feed and bedding, feathers, hair and animal dander, and other associated dust. According to a 1990 study, fugitive dust from agricultural crops and livestock contributed 3.5 million tons.

MANURE (System Stressor)
The term manure sometimes refers to combinations of animal feces and urine only, but for the purposes of this assessment, it will include other materials such as bedding, soil, wasted feed, and added water. Livestock manure is extremely beneficial for plant growth, improving soil structure, and increasing fertility levels. However, if improperly handled, it can be an environmental hazard, resulting in runoff into surface streams and groundwater. Manure contamination can increase nitrate levels in groundwater and cause microbial contamination, fish kills, and odors. Concentrated livestock production facilities increase the potential for pollution by manure because manure production frequently exceeds land application requirements based on plant fertility needs. This can result in excess nutrients and organic matter being delivered to surface- and groundwaters through runoff or leaching.

AMMONIA VOLATILIZATION (Ecological Effect)
Ammonia nitrogen (NH_3-N), a gaseous form of ammoniacal nitrogen, is formed during the process of handling, storage, and utilization of manure. Urea in manure decomposes rapidly to

ammonium (NH_4) and in turn converts very quickly to ammonia (NH_3) as the pH increases and the manure begins to dry. Ammonia is extremely volatile and the nitrogen is quickly lost to the atmosphere by volatilization, a process whereby a substance is converted from a solid or liquid to a gas.

Ammonia is an irritant and has been known to create health problems in animals in confinement buildings. Irritation of the eyes and respiratory tract are common problems from prolonged exposure to this gas. It is also associated with soil acidification processes via an acid-rain type phenomenon.

METHANE EMISSIONS (Ecological Effect)
Various gases are produced as animal waste is degraded by micro-organisms. Under anaerobic (with no oxygen) conditions, one of the primary gases that is produced is methane. Livestock manure contains undigested organic material. When handled under anaerobic conditions, microbial fermentation produces methane. About 60 to 70 percent of the gas generated in an anaerobic lagoon is methane. While methane's concentration in the Earth's atmosphere is small, it has a sizable contribution to potential future warming because it is a potent greenhouse gas and because methane's concentration has been increasing dramatically. Its global concentration has more than doubled over the last two centuries, after remaining fairly constant for the preceding 2,000 years, and continues to rise.

SMOTHERING AND SUFFOCATION OF ORGANISMS AND HABITAT (Ecological Effect)
Confined livestock production operations frequently store, treat and handle large volumes of manure and other forms of agricultural waste for land application at a later date. Storage and treatment may be done in an earthen lagoon or holding pond or some other type of structural facility (concrete, wood or steel). Large volumes of the stored material are hauled to the field for application using various types of manure spreaders and tanks. Occasionally, due to natural phenomenon such as severe rainfall or due to equipment failure, large volumes of manure and waste are spilled into the environment either directly from the storage facility or in the process of transporting waste to the field. When this occurs, the sudden, large discharge of organic matter into a water body results in direct suffocation of aquatic life (plugging of fish gills, and so forth) and smothering of associated life and habitat, including eggs and vegetation. This also includes the subsequent effects from O2 depletions.

DEAD ANIMALS (System Stressor)
Every livestock and poultry facility experiences loss of animals by death. The disposal of dead animals is a major environmental concern. Dead animals that are not disposed of properly result in odors and harmful pathogens contaminating the environment.

WATER CONSUMPTION (System Stressor)
All large livestock operations require significant quantities of water. Aside from the water that is consumed by the animals themselves, which is a considerable amount, particularly with dairy operations, water is frequently used for flushing manure and diluting waste for handling. Due to the vertical integration of the poultry industry and increasingly with the hog industry, large production facilities are frequently located within close proximity of each other. As a result,

there is a large demand placed on the local aquifer or water supply that may result in reduction or depletion of the water source.

WASTEWATER PRODUCTION (System Stressor)
As previously mentioned, water is frequently used for flushing manure, particularly with swine operations, and also for diluting waste to obtain the desired consistency for handling. In addition, there are other sources of agricultural wastewater that must be handled. For example, water is used to wash cows' udders and to flush out milking equipment used in dairy operations. Likewise, most dairy operations have an uncovered holding or "loafing" area where animals deposit significant amounts of manure. Runoff water resulting from rainfall flows through these areas and is subsequently contaminated. This manure contaminated water is directed to storage facilities, mixed with waste from other sources and eventually must be utilized or disposed.

REDUCED WATER QUANTITY (Ecological Effect)
Due to the large amounts of water required by confined livestock production facilities, local water supplies may be reduced significantly, thereby impacting local residents who depend on the water source for domestic supplies.

LAND DISTURBANCE (System Stressor)
Land disturbance results from construction activities related to installation of livestock housing and related facilities. If erosion and sediment control measures are not properly implemented, erosion and sediment laden runoff result. Land disturbance also occurs where animals are concentrated in unpaved feedlots. In addition to the resulting erosion and sediment delivery resulting from rainfall and runoff pollutants such as nutrients, organic matter and pathogenic bacteria from manure deposited in the feedlot, are delivered to nearby water bodies.

SOIL EROSION (System Stressor)
Soil erosion occurs when soil particles become detached and are translocated by natural forces, such as wind and rain (runoff). Such activity reduces productivity and detracts from the appearance of the source area and also damages the delivery area in the form of deposited sediments.

Soil erosion associated with confined livestock production facilities generally occurs from two activities. First, there is the disturbance and denuding of the soil during the construction of livestock housing and related facilities. Generally, this is a short-term situation if the construction areas are stabilized with vegetation once the facilities are complete. The second situation occurs when large numbers of livestock are confined outdoors, by fencing in a relatively small area. This typically occurs with beef and dairy production operations.

VISUAL DETERIORATION (Ecological Effect)
Often installing livestock housing requires significant amounts of land clearing and grading. As a result, a setting previously viewed as pleasing to the general public is destroyed. Unpaved loafing or exercise lots, particularly adjacent to a stream, are unsightly and undesirable to most people. These areas generally deteriorate with continued use resulting in destruction of vegetation and formation of rills and gullies that degrade the landscape even further.

QUALITY OF LANDSCAPE RESOURCES (Assessment Endpoint)
Well-designed and managed farmsteads and livestock production facilities provide scenes that are often viewed as bucolic and pleasing to the general public. Each farm can be viewed as a series of spaces used for different operations linked together by roads or paths. The arrangement of structures, landform, water, and vegetation within this system affects aesthetic quality, operational efficiency, energy consumption, runoff, and specific functions on the site. Manipulation of these elements can establish desirable views, buffer noise, determine circulation of animals and equipment, manage odor, modify air temperature, affect snow or windblown soil deposition, and optimize use of available space. In addition, proper visual consideration can enhance quality of life values.

On the other hand, an unsightly farm or livestock facility presents a negative image and is often the root of other complaints made by neighboring residents. It is important, therefore that visual impact of facilities be given serious and thoughtful consideration.

POTABLE WATER SUPPLY (Assessment Endpoint)
As with the impacts of nutrient application, the addition of pathogens and bacteria to the water supply can be especially damaging to all life. Bacteria and other pathogens can be introduced to surface and ground water supplies through runoff from feedlots, holding pens; overflows of waste holding facilities; improper facility locations; or other related practices or activities. The introduced contaminants impact the overall quality of the water, whether the usage is for domestic water supply, waterfowl, aquatic habitats, or other uses.

GOOD AIR QUALITY (Assessment Endpoint)
As with nutrient application, a certain amount of odor can be expected with the spreading of manure on agricultural fields. If the manure application is not performed properly, air quality can be degraded, through both increase air particulates introduced through the mechanical practices of spreading the manure, and also through excessive concentrations of the animal waste products. Dead animals, if not handled properly, can also add to the noxious odors that can impact and irritate on-site workers and neighboring communities.

DIVERSITY OF TERRESTRIAL COMMUNITIES (Assessment Endpoint)
Because of the nature of the confined livestock operation, there is very little diversity of vegetation, if any at all. The concentration of a large number of animals in one location tends to cause a bare-ground condition. This lack of vegetation will decrease both areas for shelter, as well as sources of food for terrestrial wildlife communities. Confined livestock operations, with the extreme concentrations of livestock, result in excessive soil erosion. Nutrients, pathogens, and organic matter concentrated in these feedlots, holding pens, milking parlors, and the like, are flushed away, either through wash waters, or through runoff after a rainfall event. All of this, in concentration, adversely impacts water quality, affecting the ability to sustain terrestrial wildlife habitats.

VIABILITY OF AQUATIC COMMUNITIES (Assessment Endpoint)
Confined livestock operations can adversely impact aquatic communities through the introduction of animal wastes, bacteria, and other pathogens into water sources. The effects upon the aquatic communities are much like those described for potable water supplies. Diversity of species will decrease with increased levels of these pollutants, thereby changing the community. If the situation continues unabated, the overall viability of the community can become permanently damaged. (See Diversity of Terrestrial Communities above for additional impacts.)

SURVIVAL OF THREATENED AND ENDANGERED SPECIES
As for the terrestrial and aquatic communities, threatened and endangered species become impacted as animal wastes and pathogens are introduced, either on the land, or into water supplies. These species are affected when their aquatic and terrestrial food sources and habitats are damaged or destroyed.

2.4 ANALYSIS PLAN

As a final stage of problem formulation, an ecological analysis plan has been developed to guide the remainder of the risk analysis. The plan will be used to identify the: type of analysis that will be done: missing data and information needed for analysis; and recommendations for data collection and additional analysis.

The conceptual diagrams have established a set of hypotheses; however, this report will not quantify these hypotheses because of a lack of available data. Case studies of single areas could be used, but would not significantly improve the confidence levels for a national scale report. These would be of great use in the formulation and identification of priority areas.

Fourteen major assessment endpoints have been identified through the hypotheses advanced through the conceptual diagrams. Relationships can be shown between the assessment endpoints and the previously identified resources at risk.

Table 2.4.a Relationship between Assessment Endpoints and Resources at Risk

Assessment Endpoint	Resources at Risk
Structure of Offsite Resources and Habitats	Soil, Grazing Lands, and Wildlife Habitat
Livestock or Plant Yields	Grazing Lands, Soil
Wetland and Riparian Functions	Soil, Water, Wetlands, Wildlife Habitat
Viability of Aquatic Communities	Water, Wetlands, Wildlife Habitat
Survival of Threatened and Endangered Species	Soil, Water, Wetlands, and Wildlife Habitat
Good Air Quality	Soil, and Water
Diversity and Extent of Natural Habitats	Soil, Water, Wetlands, and Wildlife Habitat
Quality of Cultural and Historic Resources	Soil, Grazing Lands
Potable Water Supplies	Water, Grazing Lands
Diversity of Terrestrial and Avian Wildlife Species	Wildlife, Wetlands, Soil, Grazing Lands, and Water
Quality of Landscape Resources	Soil, Water, Wildlife, Wetlands, and Grazing Land

2.4.1 IDENTIFICATION OF THE TYPE OF RISK ASSESSMENT AND CHARACTERIZATION

The analysis and characterization of risks associated with EQIP will be in a narrative format. This format has been chosen because all data needed to perform a complete analysis and characterization at the confidence levels needed for decision-making is not currently available.

It is hoped that the narrative, when combined with data and information from the individual States, will provide enough information with which to characterize overall risk on a national scale.

The narrative analysis will attempt to provide an understanding and evaluation of the pathways, effects, and impacts identified in the conceptual diagrams on a national level. Additionally, an indication of where the impacts are occurring or where the potential for problems are the greatest will be discussed.

2.4.2 IDENTIFICATION OF MISSING DATA AND INFORMATION

Specific information related to the exact quantification of environmental effects attributable to agriculture versus industry or residential sources is currently not available for all identified pathways or impacts. Single event, or areawide information on agriculture's environmental impacts currently exist on a limited basis, but extrapolation of this data to a national scale would only dilute or distort the overall assessment, and could even possibly provide decision-makers with erroneous data.

Additionally, specific information is not available, for example, on actual drinking water source contaminations attributable to agriculture or the acreage of wetlands lost due to sedimentation overloading. While data exists, in the form of the EPA 305(b) Reports from the States, this is not all inclusive data, in that it is not representative of all water areas within a specific State or region.

The scale of this risk assessment and characterization also precludes the usage of currently existing environmental assessment models. Most environmental models require extensive data input, which in this case, is not available on a national scale. Models that would be available for the data currently available would not likely add any additional information of use to the risk managers, at this time.

2.4.3 RECOMMENDATIONS FOR ADDITIONAL DATA COLLECTION, ANALYSIS, AND EVALUATION

Better environmental monitoring and evaluation tools need to be designed in to properly assess and characterize the risks associated with agricultural production. Data collection, including evaluation of cumulative effects, needs to be made a part of the ongoing implementation of the EQIP to build adequate environmental impact data bases.

As additional environmental data becomes available, it is also recommended that the risk managers and assessors utilize an iterative approach to updating this risk analysis and characterization. In this manner, risk managers will be better able to redirect EQIP resources to those areas causing the most adverse impacts to the resources identified as being at risk. Until sufficient national data is available, it is additionally recommended that analysis and evaluations of the priority areas are done.

3. ANALYSIS OF ECOLOGICAL EFFECTS

Due to the lack of comprehensive data and the uncertainties associated with extrapolation of site-specific data to landscape scale the analysis of the hypotheses developed through the conceptual diagrams will be in narrative form. The discussion will be centered around the previously identified resources at risk, and the narrative analysis will attempt to provide an overall evaluation of the types and kinds of activities found to be placing the natural resources at risk.

3.1 SOIL RESOURCES

According to the NRI survey of private lands in the United States in 1992, 2.13 billion tons of soil were eroded as a result of sheet and rill erosion and wind erosion processes on cropland (See Map 3.1.a). This figure is down from the NRI estimates for 1987 and 1982 when total sheet and rill and wind erosion on cropland were 2.8 and 3.13 billion tons per year, respectively. Map 3.1.b shows croplands across the US.

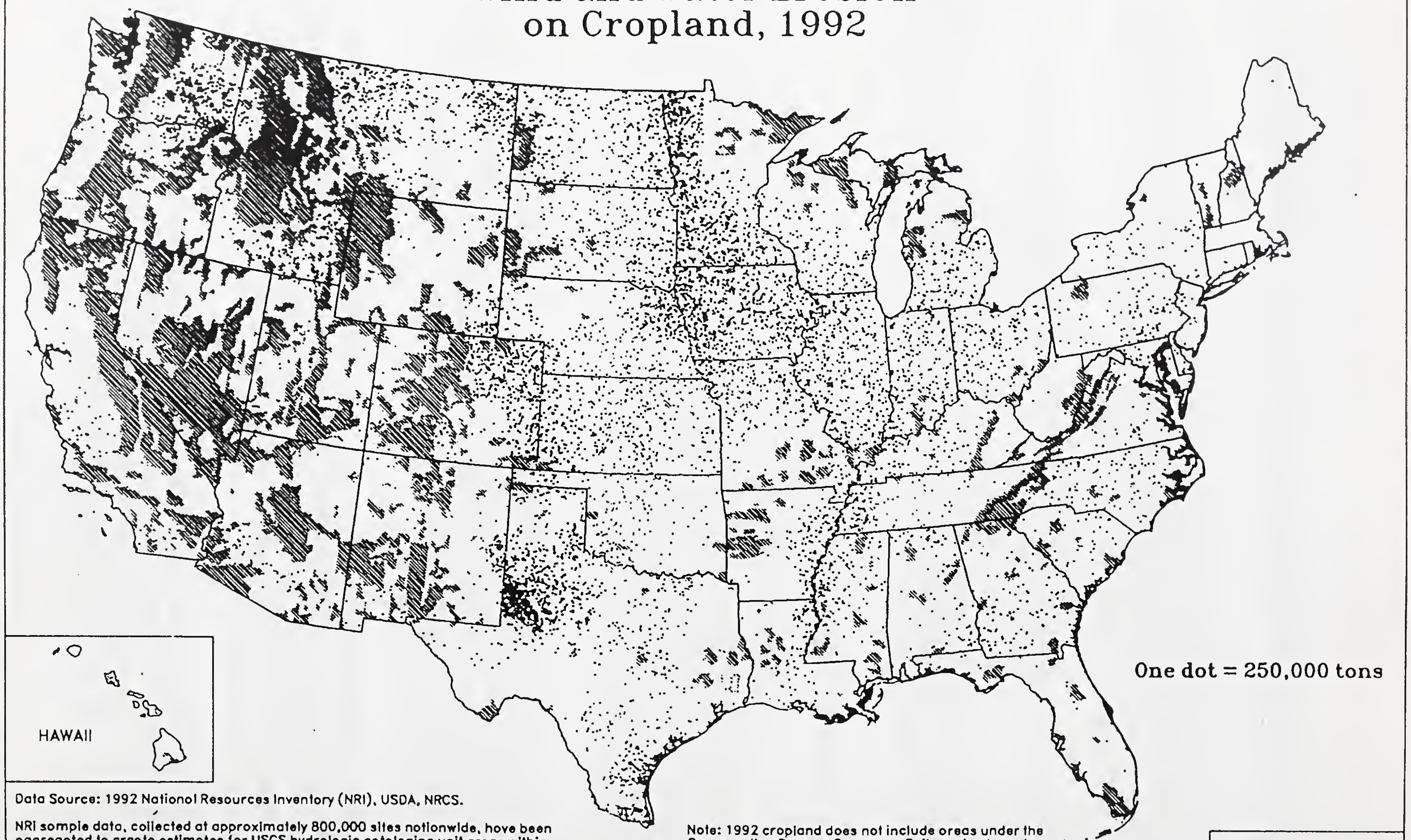
Areas of the country exhibiting excessive soil erosion losses due to the effects of water are the Midwestern States in the lower Mississippi River Basin; the Ohio River Basin; the Tennessee and Cumberland River Basins; and portions of the Missouri Valley Basin, including Iowa and northern Missouri. Excessive damages from wind erosion are found primarily in the western U.S., in the area of the Great Plains.

The declines in sheet and rill and wind erosion on cropland during the 10-year period of 1982-92 are largely credited to three major factors: the CRP, which removed approximately 39 million acres of highly erodible land (HEL) from crop production; the Conservation Compliance provisions of the 1985 Farm Bill; and the evolution of agronomic practices and conservation

U.S. Department of Agriculture

Natural Resources Conservation Service

Wind and Water Erosion on Cropland, 1992

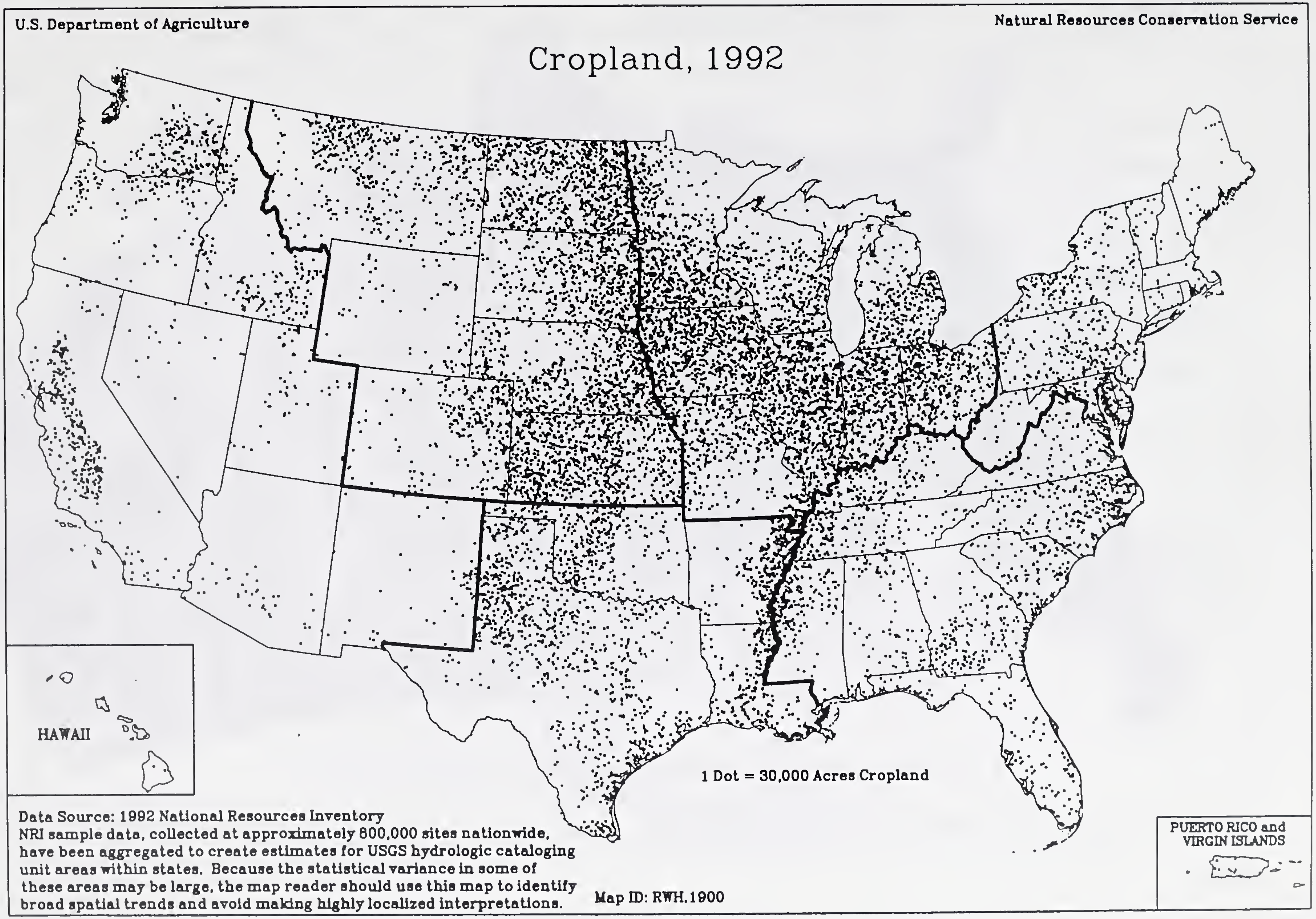


Data Source: 1992 National Resources Inventory (NRI), USDA, NRCS.

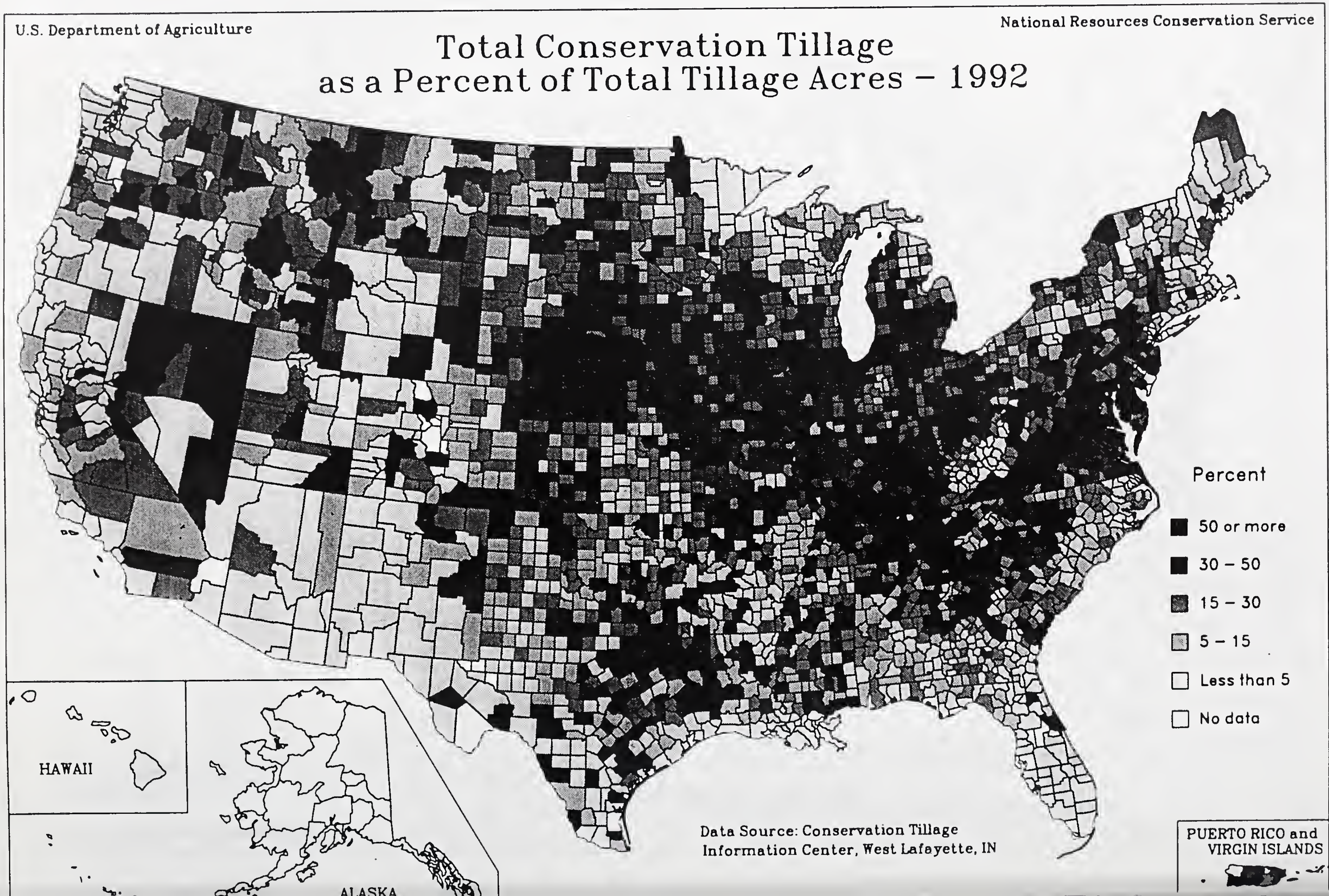
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Note: 1992 cropland does not include areas under the Conservation Reserve Program. Soil erosion by water includes sheet and rill erosion and excludes gully erosion.

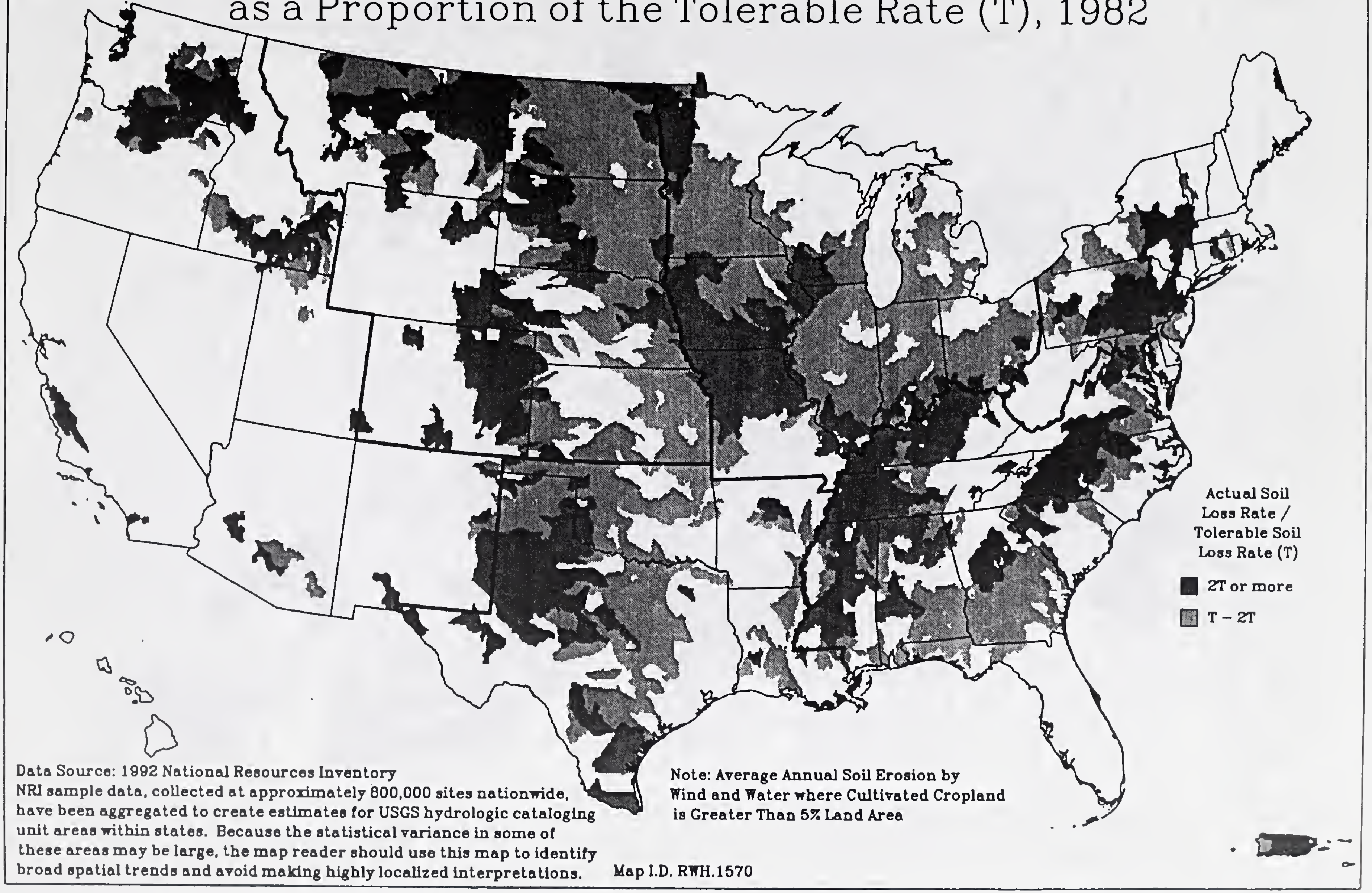
Map generated by Natural Resources Inventory and Analysis Div., Washington, D.C., January 1995. (Map I.D. DB01003)


U.S. Department of Agriculture
Natural Resources Conservation Service
Cropland, 1992
HAWAII
1 Dot = 30,000 Acres Cropland
Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.
Map ID: RWH.1900
PUERTO RICO and VIRGIN ISLANDS

Map 3.1.c


U.S. Department of Agriculture
National Resources Conservation Service
Total Conservation Tillage
as a Percent of Total Tillage Acres – 1992
Percent
50 or more
30 – 50
15 – 30
5 – 15
Less than 5
No data
HAWAII
ALASKA
PUERTO RICO and
VIRGIN ISLANDS
Data Source: Conservation Tillage
Information Center, West Lafayette, IN

Average Annual Soil Erosion on Cultivated Cropland as a Proportion of the Tolerable Rate (T), 1982

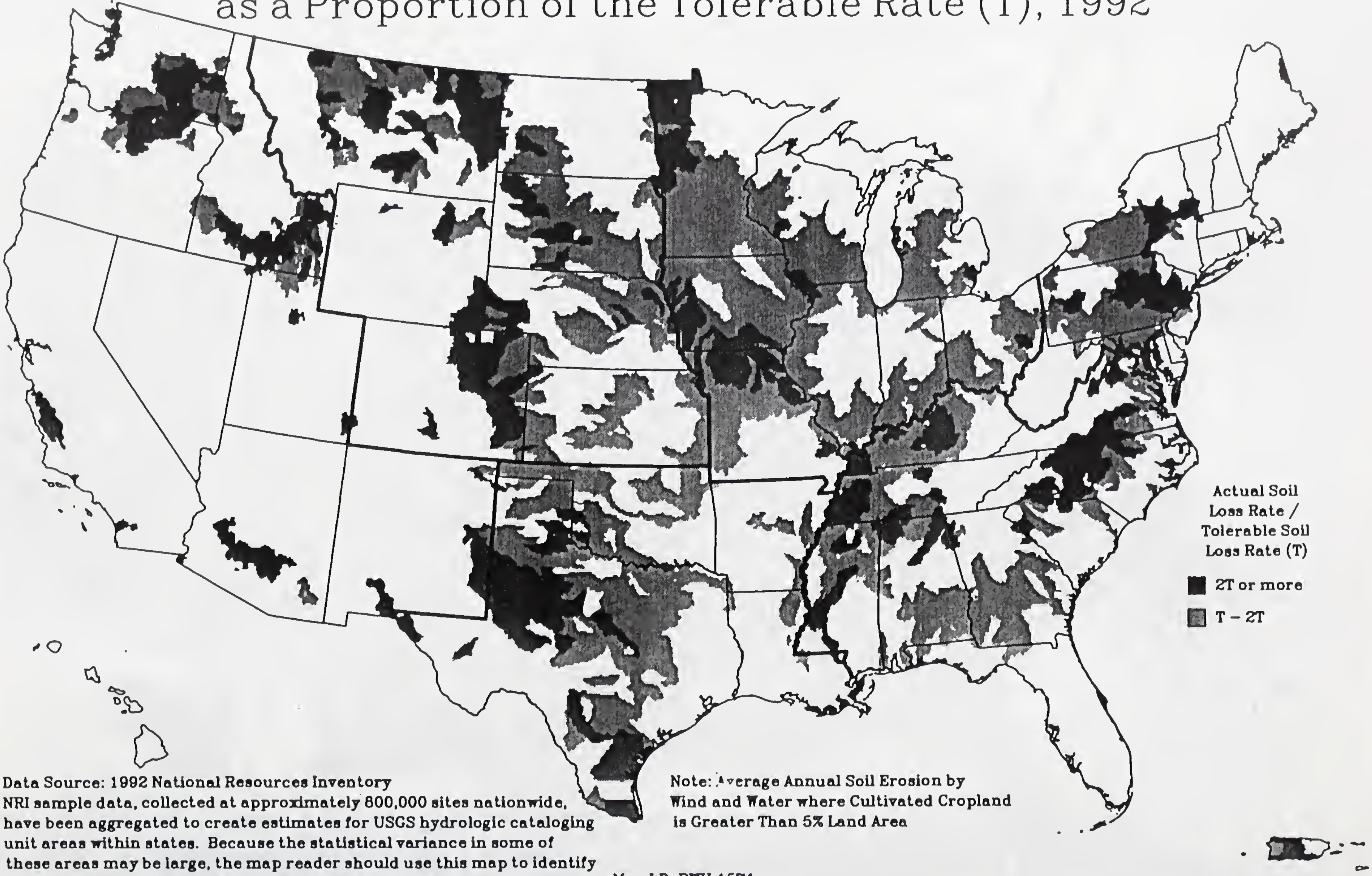


Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Note: Average Annual Soil Erosion by Wind and Water where Cultivated Cropland is Greater Than 5% Land Area

Map I.D. RWH.1570

Average Annual Soil Erosion on Cultivated Cropland as a Proportion of the Tolerable Rate (T), 1992



Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Note: Average Annual Soil Erosion by Wind and Water where Cultivated Cropland is Greater Than 5% Land Area

Map I.D. RWH.1571

tillage technology, mainly no-till, ridge-till, and strip-till technologies (Map 3.1.c.). The Conservation Compliance provisions contributing to the decline in erosion required USDA program participants seeking USDA benefits, and who had HEL cropland, to develop and implement conservation systems to protect the natural resource base and diminish offsite damages from agricultural nonpoint source pollutants (NPS).

When examined together, the two maps (3.1.d & 3.1.e) of soil erosion in the lower 48 States show the accomplishments of the 1985 and 1990 Farm Bills, as well as several other environmentally oriented programs. In comparing the two maps, it is readily seen that in most cases, the large areas of cropland soil erosion identified in 1982 were significantly reduced in size over the 10-year period from 1982-92 and, in many cases, erosion rates were cut in half. Map 3.1.f shows the distribution of the CRP farmer/rancher contract acreages.

In the lower 48 States, areas where highly erodible lands (Maps 3.1.g) represent a large percentage of the total cropland for the state, are located in the Northeast from southern New York through Pennsylvania into Maryland, Delaware, western Virginia, and the western Carolinas; the Ohio and Tennessee Valleys, including most of Kentucky, Tennessee, northern Georgia, and northern Alabama; the Mississippi Valley including southern Mississippi and portions of Arkansas, Missouri and Iowa; the Great Plains region from central Montana to southwestern Texas; and the Columbia River Basin.

Another important set of data from the 1992 NRI concerns conservation treatment needs. According to the 1992 NRI a total of 436 million acres of private cropland, pastureland, forestland, and other rural lands have a need for treatment with one or more conservation practices. Acres in need of treatment are as follows: 204 million acres of cropland; 158 million acres of forestland; 58 million acres of pastureland; and 15 million acres of other remaining agricultural lands. Other lands include CRP lands, farmsteads, and other farm structures, field windbreaks, barren lands such as salt flats, or exposed rock and marshland.

Map 3.1.h is a composite of all the treatment needs for cropland as a percentage of total cropland area. A general analysis of the map shows a trend for cropland treatment needs in the Appalachian and Northeastern areas; the southeastern United States; the upper Mississippi and Missouri valleys, including western Wisconsin, eastern Nebraska, Iowa and, portions of Missouri and Arkansas; the Great Plains area from central Montana, western South Dakota, and Nebraska, eastern Colorado, the Oklahoma panhandle area, and Texas; and the Palouse area of Washington State.

Colacicco, et.al. (1989), among others, estimated on-farm productivity damages alone from sheet, rill, and wind erosion to range between $500 million and $1.2 billion for 1983. It should be noted that the above mentioned NRI erosion data do not include estimates for other categories of erosion, such as classic and ephemeral gully erosion, streambank and channel erosion, and mass movement (landslides and slipages). Nor do the erosion estimates take into account another facet of the resource degradation process, sediment delivery. Erosion is the process of soil movement within a given site and sediment delivery involves the transport of eroded soil from a given site into drainageways, streams, rivers, and water bodies.

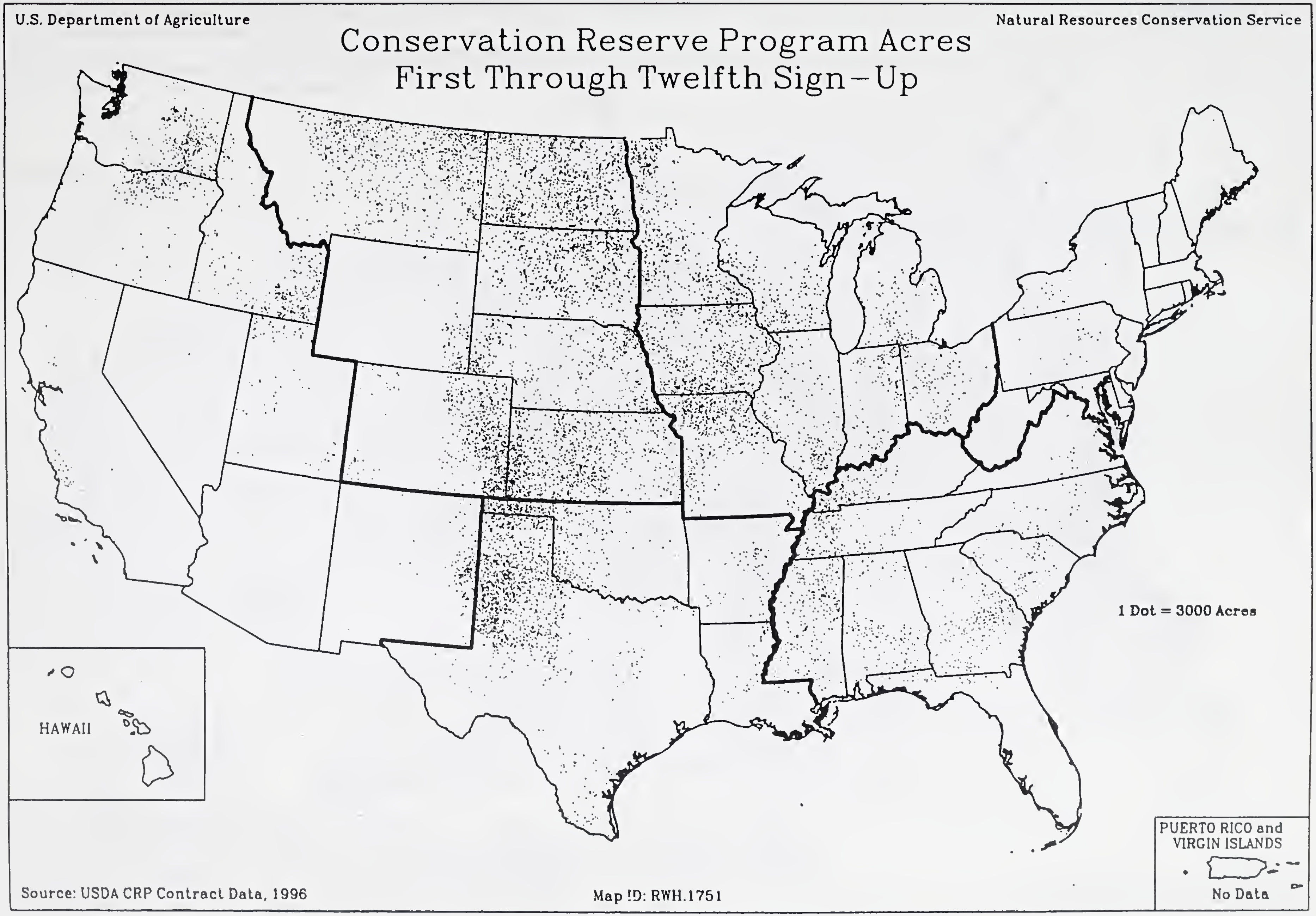
National estimates for these other erosion and sediment transport processes do not currently exist because they are much more difficult to evaluate and estimate, and statistically reliable inventories do not exist. However, these processes are no less important as they contribute significantly to some of the Nation's environmental problems. Soil erosion or movement of soil within agricultural fields directly affects a farmer's operational efficiency and long-term productivity, but soil erosion can harm areas away from fields when soil particles and potential pollutants adsorbed to them leave fields.

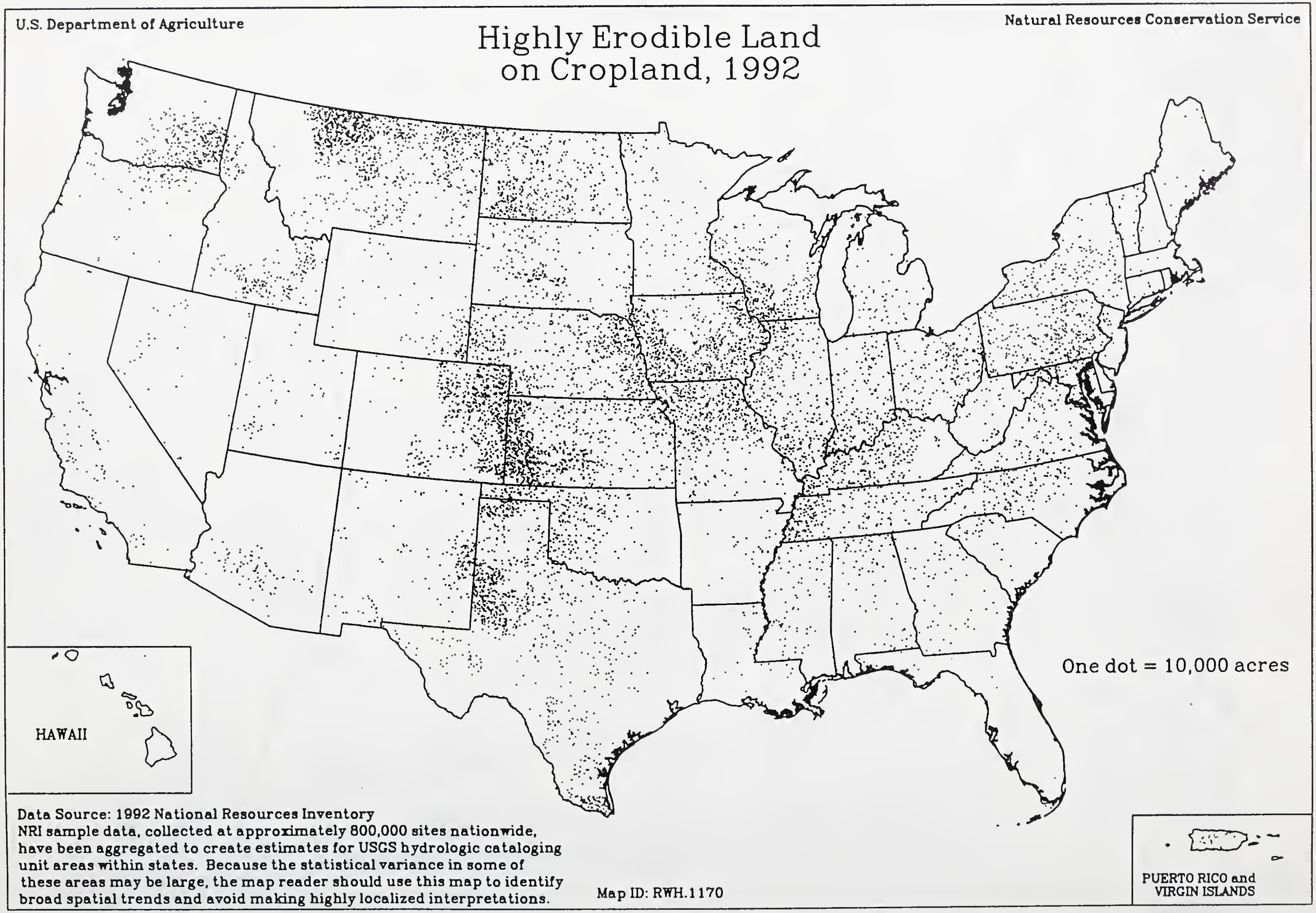
The salinity content of the soil resources also adversely impacts soil quality, which in turn, impacts agricultural productivity for domestic crop and livestock production, and affects terrestrial and avian wildlife habitats, and water supplies. High salinity levels alter the soil structure, promoting waterlogging conditions, causing plant toxicities, and reducing the plant's ability to absorb water. Map 3.1.i shows the locations of soils in the lower 48 States that exhibit salt-related problems on non-Federal lands, whether those problems are naturally occurring, or related to human activities, including agriculture. Problem areas of importance are: the Great Plains, particularly North and South Dakota, the Upper Arkansas Basin, the Rio Grande RiverBasins, the Upper and Lower Colorado River Basins, the Imperial and Coachella valleys of California, the lower Gila River in Arizona, the Great Basin area, and the Pacific Northwest.

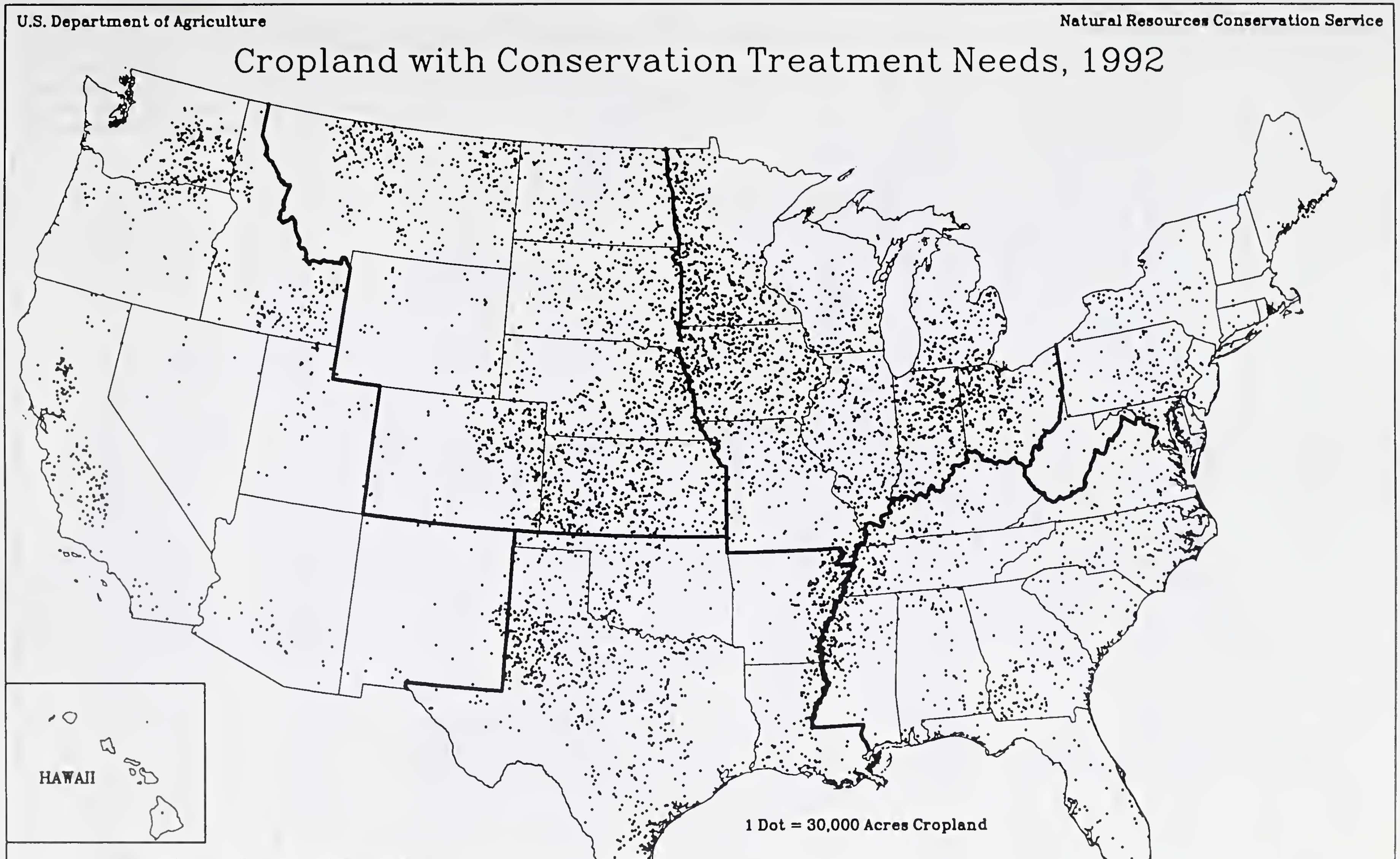
Timber harvesting can also have devastating effects upon the soil resources. Even when harvesting is done in accordance to local regulations, and with correct permits, if done over a sustained period of years in a concentrated area with no planned revegetation, the excess erosion and resultant sediment delivery can cause severe consequences. The cumulative effects of timber harvest over a period of years can have dramatic effects on the environment. A study of the North Fork Hoh River in the Olympic Peninsula over the period of years from 1960-90 revealed a change in forest vegetation from undisturbed old growth forest to an almost complete loss of vegetative canopy in the thirty year period. The study revealed that the extensive timber harvest resulted in excessive soil erosion. Research also revealed that, while each patch of timber was harvested under approved logging permits, the cumulative effects of the harvest over a 30-year period resulted in the area experiencing severe landsliding and erosion, causing sedimentation in salmon spawning and rearing areas. (Source: Considering Cumulative Effects Under the National Environmental Policy Act, Council on Environmental Quality.)

The costs associated with soil erosion and sediment delivery are significant burdens on the ecology and economy of the Nation. However, they are less than the damages that would occur if programs designed to deal with onsite productivity maintenance and offsite resource degradation had not been in place for the past 60 plus years. Ribaudo et.al. (1989) estimated that the onsite productivity benefits of existing conservation programs amounted to approximately $100 million annually.

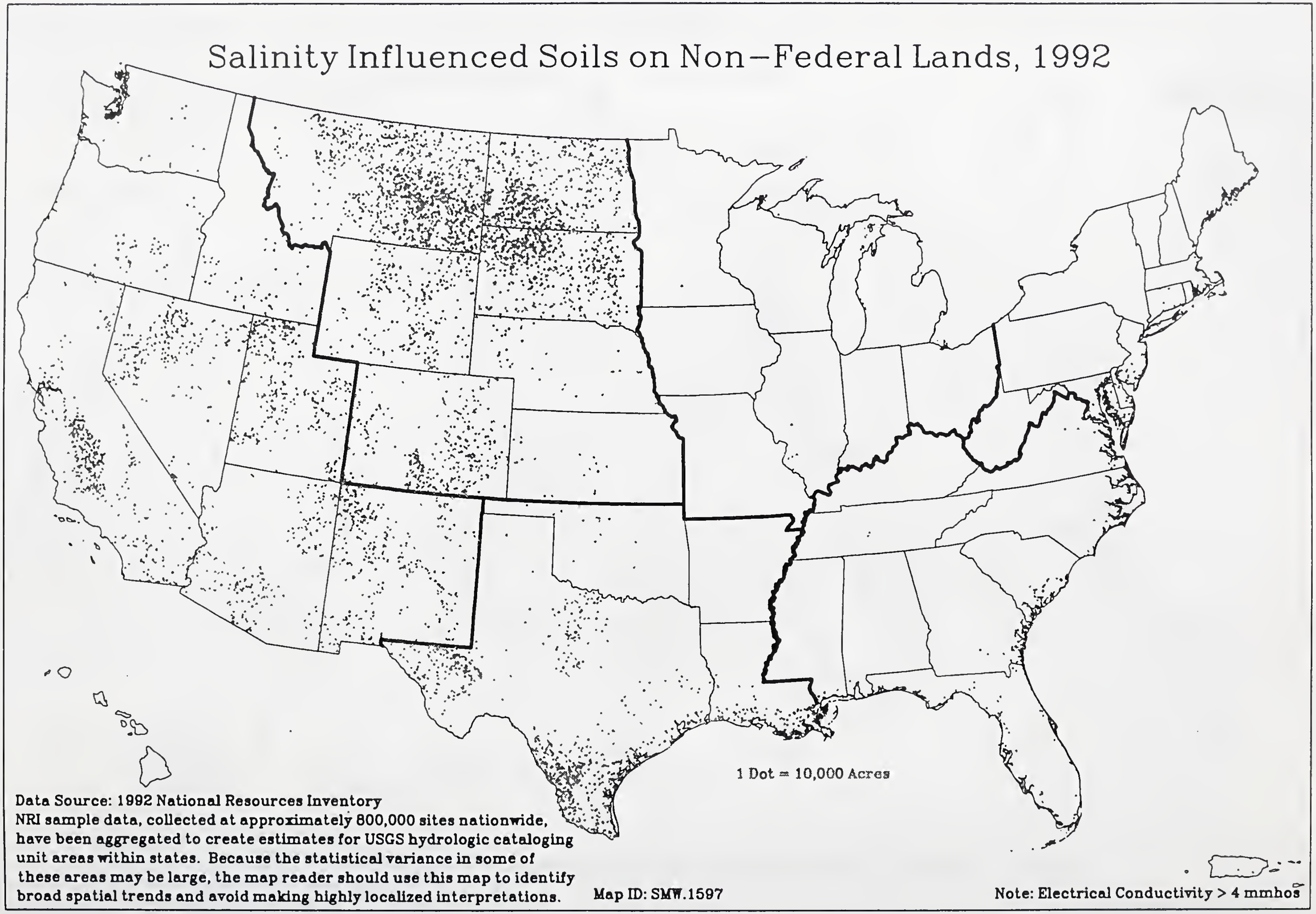
Map 3.1.f


U.S. Department of Agriculture
Natural Resources Conservation Service
Conservation Reserve Program Acres
First Through Twelfth Sign-Up
1 Dot = 3000 Acres
HAWAII
PUERTO RICO and
VIRGIN ISLANDS
No Data
Source: USDA CRP Contract Data, 1996
Map ID: RWH.1751


U.S. Department of Agriculture
Natural Resources Conservation Service
Highly Erodible Land on Cropland, 1992
HAWAII
One dot = 10,000 acres
PUERTO RICO and VIRGIN ISLANDS
Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.
Map ID: RWH.1170



Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.


Salinity Influenced Soils on Non-Federal Lands, 1992
1 Dot = 10,000 Acres
Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.
Map ID: SMW.1597
Note: Electrical Conductivity > 4 mmhos

3.2 SURFACE AND GROUNDWATER RESOURCES

3.2.1 SUSPENDED SEDIMENT YIELDS

In 1993, the U.S. Geological Survey found that the delivery of suspended sediments, nitrates and total phosphorous, including phosphorous attached to soil particles, which is the single largest source, were highest in Hydrologic Units Areas (HUAs) where corn and soybean production dominated, and lowest in HUAs where wheat production was the primary landuse. Mixed agricultural production areas (areas with wheat, corn, and soybeans) yielded moderate to high concentrations of the same nonpoint source pollutants. Table 3.2.1.a provides a summary of sediment yields by landuse category for the entire nation.

According to USDA's "RCA III-Sediment As A Pollutant in the United States," sediment continues to be the greatest nonpoint source pollutant by volume, and agriculture continues to be the greatest contributor of nonpoint source pollutants."

Table 3.2.1.a Suspended Sediment Yield by Land Use

	Suspended Sediment Yield 1980-1989	
Land Use	Tons per Sq. Mile per Year (Average)	Percentage Change per Year
Agriculture		
Wheat	10	+0.8
Corn and Soybeans	100	-0.1
Mixed	79	-0.7
Urban	23	-0.6
Forestlands	31	-0.3
Rangelands	33	-0.2

Note: USGS gauges measure only suspended load, sediment that is carried in suspension. Bedload is sediment that is transported along the streambed and estimation of transport and fate of this sediment is very difficult to sample with statistical reliability.

The Midwestern States show the greatest potential for excessive sedimentation damage to watercourses and water bodies (Map 3.2.1.a). With the exception of the Inter-Mountain and High Desert areas, the remainder of the Nation has moderate potential for problems resulting from sedimentation.

Sediment is a product of soil erosion, or, as the National Research Council (NRC) in 1993 characterized it, sediment is a "resource out of place." The same NRC report summarized the importance of the relationship between soil erosion on agricultural lands and the damage produced by sediment as follows:

> Agriculture has a great impact on sediment deposition. Judson (1981) estimated that river-borne sediments carried into the oceans increased from 9 billion metric tons (10 billion tons) per year before the introduction of intensive agriculture, grazing, and other activities to between 23 billion and 45 billion metric tons (25

billion and 50 billion tons) thereafter. Dudal (1981) reported that the current rate of agricultural land degradation, primarily because of soil erosion, is leading to an irreversible loss of productivity on about 6 million ha (15 million acres) of fertile land a year worldwide. Crop productivity on about 20 million ha (49 million acres) each year is reduced to zero or becomes uneconomical because of soil erosion and erosion-induced degradation (Lal, 1988). Since humans first began cultivating crops on a yearly basis, soil erosion has destroyed about 430 million ha (1,063 million acres) of productive land globally (Lal, 1988). Buringh (1981) estimated that the annual global loss of agricultural land is 3 million ha (7 million acres) because of soil erosion and 2 million ha (5 million acres) because of desertification.

Of the total 0.9 billion metric tons (1 billion tons) of sediment carried by rivers from the continental United States, about 60 percent is estimated to be from agricultural lands (National Research Council, 1974). The offsite damages ("offsite" refers to locations where damages are due primarily to deposition of eroded material) caused by sediments in the United States are exorbitant. For example, several million cubic meters of sediment are washed into U.S. rivers, harbors, and reservoirs each year, and dredging of these sediments requires significant financial resources.

3.2.2 WATER IMPAIRMENT AND TREATMENT COSTS

More than 50 percent of the 1,627 reservoirs for which NRCS has data entered into a national database, will be half full of sediment by the year 2018. More than 40 percent of these reservoirs are already half full of sediment. Based on the rate of deposition calculated for the last survey of these reservoirs by NRCS, some 500,000 acres, about 60 percent of the Missouri River bottomland, were covered by sand, from a thin layer to a blanket up to 10-feet deep, as a result of the 1993 floods alone. The cost of recovering Missouri's sand blanketed bottomlands by bulldozing away the sediments has been estimated at up to $3,000 per acre. The total estimated cost of recovery for Missouri's bottomlands is around $300 million. (Source: RCA III Sediment as a Pollutant in the United States, Working Paper No. 15, USDA, NRCS.)

The 1989 Colacicco study estimated total offsite damages from sheet, rill, and wind erosion on agricultural lands to be more than twice the value of onsite damages to soil productivity. They estimated the offsite damages to range between $1 billion and $2.5 billion annually and did not include damages from other agricultural sources of erosion such as gully, streambank, and channel erosion.

There are two main categories of offsite damages for transportation infrastructure due to erosion and sedimentation processes: sedimentation of navigational channels and harbors, and of road ditches and culverts. Damages to navigation can be further subdivided into four different cost categories: the cost of increased accidents to ships; the cost of delays and using smaller ships; the

cost of dredging; and the cost of impacts of suspended sediment on cooling and other equipment on ships.

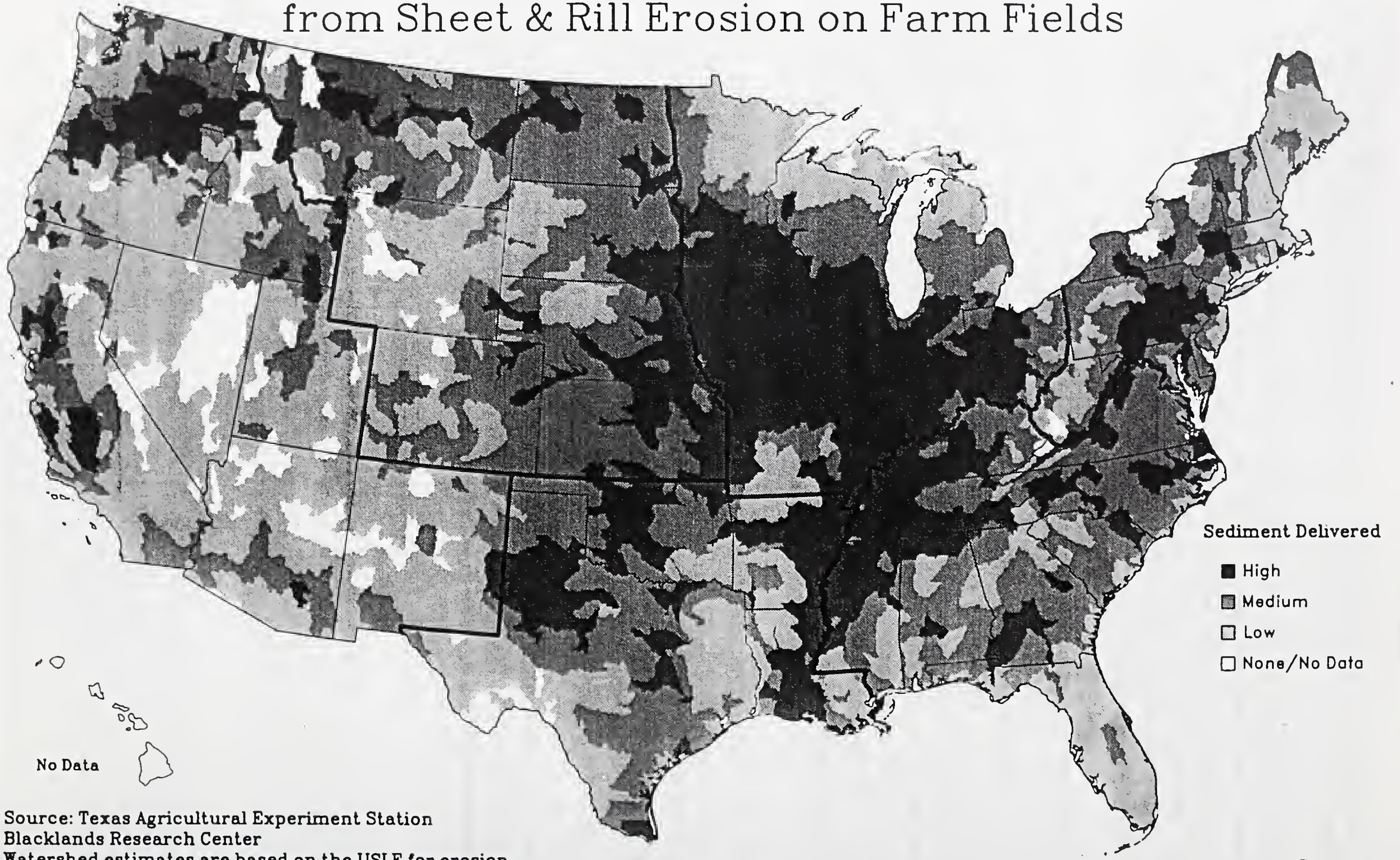
The damages associated with accidents, delays, and the use of smaller vessels have not been estimated since little information is available. Examples of these damages include damaged or broken propellers and shafts, hull damage, costs of transferring cargo to shallow-draft vessels, elimination of ship channels, and delays associated with shoaling, that are compounded by low tides. Damages to engines and other equipment that are caused by suspended sediment are nearly impossible to estimate.

The largest damage costs to navigation are associated with the dredging of channels and harbors. The U.S. Army Corps of Engineers between 1983 and 1994 spent an average of $476 million annually on dredging rivers and harbors. The amount of material dredged by the Corps averages 300 million cubic yards annually with an average cost of $1.60 per cubic yard. Thus, during the period covered from fiscal year (FY) 1984 to FY 1994, the Corps spent more than $4.762 trillion on dredging of our Nation's rivers and harbors. These costs mainly include the costs of dredging only and do not include the costs of transport and proper disposal of the dredged materials. Studies by the Corps of Engineers and the General Accounting Office indicate that the cost of proper sediment disposal can increase the total cost of dredging by 65 to 1,000 percent. Typical cost increases due to disposal range from 100 to 200 percent.

Ribaudo, et.al. 1989, estimated offsite benefits from existing conservation programs on the order of 2 to 2.5 times the level of onsite benefits, or around $200 million. It is important to note that the Ribaudo estimates were based on sheet and rill erosion only, i.e., gully, wind, streambank, and channel erosion were not included. Clark and associates (1985) estimated that sediment and chemicals attached to sediment cause up to $6.8 billion in offsite damages every year, of which $2.2 billion were attributed to cropland erosion.

The following tables provide a national level perspective that summarizes the current conditions and trends since 1988 for U.S. surface waters, and profiles the linkages between all sources of pollutants and the specific causes of impairment.

Sediment Delivered to Rivers and Streams from Sheet & Rill Erosion on Farm Fields



Source: Texas Agricultural Experiment Station
Blacklands Research Center
Watershed estimates are based on the USLE for erosion from agricultural lands and a delivery ratio multiplier to convert erosion to sediment loads.

Map ID: SMW.1695

Table 3.2.2.a indicates that a much smaller proportion of our Nation's rivers have been monitored and assessed for water quality than is the case with water bodies and estuaries. This table also indicates that water quality has degraded in several categories of our Nation's rivers, lakes, and estuaries.

Table 3.2.2.b. indicates that agriculture is one of the main sources of water quality impairment. Table 3.2.2.c. indicates that siltation, nutrients, pathogens, and organics are the largest individual causes of impairment. It should also be kept in mind that the combined effects have a negative synergistic impact, not just on our Nation's water, but also on the broader environment. Water treatment costs associated with excess sediment, is estimated between $200 and $500 million annually.

Table 3.2.2.a Status of the Nation's Surface Water Quality, 1992, as a Percent of Assessed Waters

Category	Rivers	Lakes	Estuaries
Supports Designated Uses	62	56	68
Partially Supports Designated Uses	25	35	23
Not Supporting Designated Uses	13	9	9
Meets Fishable Goals	66	64	94
Not Meeting Fishable Goals	26	33	4
Goals Not Attainable	8	3	1
Meets Swimmable Goals	71	77	83
Not Meeting Swimmable Goals	10	16	12
Goals Not Attainable	19	7	5

Source: U.S. EPA 305(b) report. 1992 as reported to them by the States and published in USDA/Economic Research Service Agricultural Handbook Number 705 - "Agriculture Resources and environmental Indicators." December 1994.

Table 3.2.2.b Sources of Impairment to Surface Water Quality, 1992, as a Percentage of Impaired Waters

Source of Impairment	Rivers	Lakes	Estuaries
Agriculture	72	56	43
Hydro/Habitat Modification	7	23	10
Storm Runoff/Sewers	11	24	43
Land Disposal	--	16	--
Municipal/Industrial	22	21	76
Other	19	29	12

Source: U.S. EPA 305(b) reports. 1992 as reported to them by the States and published in the USDA Economic Research Service Agricultural Handbook Number 705 - "Agricultural Resources and Environmental Indicators." December 1994

Table 3.2.2.c — Causes of Impairment to Surface Water Quality, 1992, as a Percentage of Impaired Waters

Cause of Impairment	Rivers	Lakes	Estuaries
Siltation	45	22	12
Nutrients	37	40	55
Pathogens	27	8	42
Organic Enrichment	24	24	34
Pesticides	26	9	7
Salinity	12	--	7
Heavy Metals	6	41	4
Suspended Solids	13	6	11
Other	19	35	15

Source: U.S. EPA 305(b) reports, 1992 as reported to them by the States and published in the USDA Economic Research Service Agricultural Handbook Number 705 - "Agricultural Resources and Environmental Indicators," December 1994.

Table 3.2.2.d. indicates that for the reporting period 1990-1991 more than 30 percent of the assessed river miles and lake acres in the entire U.S. were impaired with respect to aquatic life and fish consumption. Impairment by region varied greatly. More than fifty percent of the assessed rivers in the Delta, Northern Plains, Pacific, and Corn Belt regions were reported impaired, as well as more than half the lakes in the Northern Plains and Mountain States. Drinking water was reported impaired in 13 to 15 percent of the assessed rivers and lakes.

Table 3.2.2.d — Principal Use Impairments from all Sources by Type of Water Body Assessed by Farm Production Region, 1990-1991

	Aquatic Life			Fish Consumption			Drinking Water		
Region	Rivers	Lakes	Estuaries	Rivers	Lakes	Estuaries	Rivers	Lakes	Estuaries
	Impaired Uses as a Percentage of the Areas Assessed								
Northeast	6	14	44	0	8	4	17	4	--
Appalachia	33	7	9	24	5	9	23	3	--
Southeast	26	43	32	25	32	0	0	44	--
Lake States	13	13	--	10	78	--	0	0	--
Corn Belt	56	41	--	7	13	--	0	23	--
Northern Plains	63	62	--	41	73	--	34	35	--
Delta States	83	17	6	25	33	0	12	0	--
Southern Plains	8	0	--	2	0	2	5	10	--
Mountain States	39	52	--	14	53	--	15	20	--
Pacific States	62	43	21	45	17	71	0	0	--

Source: U.S. EPA 305(b) reports, 1992 as reported by the States and published in the "Water Quality and Agriculture: Status, Conditions, and Trends," USDA/NRCS, Working Paper #16, January 1996/

Miles of water-quality impairments for assessed rivers and streams from all sources, including agricultural, are shown in Table 3.2.2.e.

Table 3.2.2.e — Principal Causes of Impairment in Rivers and Streams from all Sources for Assessed Water, by Farm Production Region, 1990-1991. (Miles)

Region	Siltation	Nutrients	Pathogens	Pesticides	Suspended Solids	Salinity
Northeast	5,390	6,140	4,860	1,030	1,630	540
Appalachia	8,370	1,940	4,610	700	100	250
Southeast	1,420	2,630	3,480	460	270	0
Lake States	3,360	4,610	2,570	270	1,010	680
Corn Belt	25,290	16,770	4,020	9,660	1,020	150
Northern Plains	2,200	2.090	14,750	3,480	10,060	10,570
Delta States	32,690	33,540	13,000	34,910	3,300	3,220
Southern Plains	3,300	3,050	2,700	3,020	2,350	1,640
Mountain States	12,220	7,880	2,310	550	9,190	9,250
Pacific States	3,730	1,700	4,290	2,360	280	130
United States	97,980	81,640	60,310	57,170	29,270	26,430

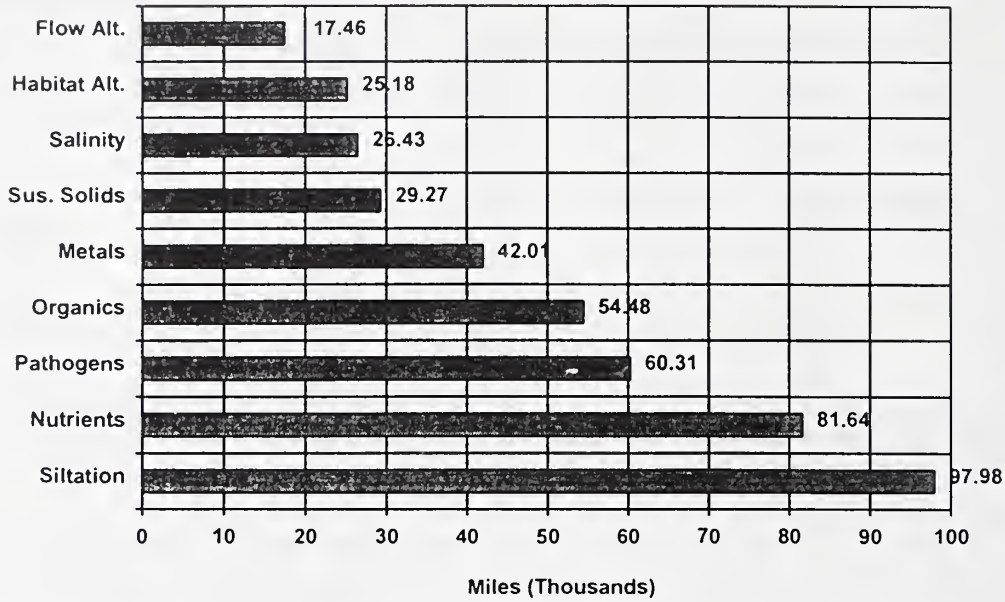
Source: U.S. EPA 305(b) reports. 1992 as reported by the States and published in the "Water Quality and Agriculture: Status. Conditions, and Trends." USDA/NRCS, Working Paper #16, January 1996/

The following graph 3.2.2.a provides additional national and regional level details regarding the principal causes of impairments to rivers and streams. As shown, principal impairments to assessed rivers and streams are being caused by siltation, nutrients, pathogens, and organics respectively.

Siltation represents a significant problem in the Delta States and the Corn Belt Farm Production Regions; nutrients significantly impact streams and rivers in the Delta States and the Corn Belt Regions; pathogens adversely impact streams and rivers in the Northern Plains and the Delta States regions; and pesticides contribute impacts in the Delta States.

Graph 3.2.2.b illustrates the main causes of impairments of assessed lakes, reservoirs, and ponds for the Nation, while Table 3.2.2.f shows the principal causes of the impairments by Farm Production Region.

Causes for Assessed River & Stream Impairments from 1992 US EPA 305(b) report



Main Causes for Impairment of Assessed Lakes, Reservoirs and Ponds from 1992 US EPA 305(b) report

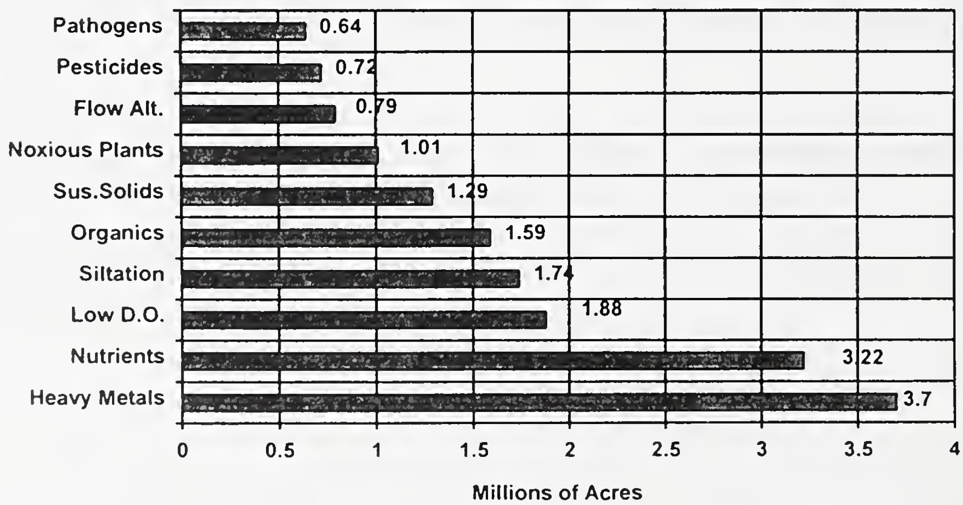


Table 3.2.2.f	Principal Causes of Impairment in Lakes, Reservoirs, and Ponds for Assessed Water, by Farm Production Region, 1990-1991. (Acres)				
Region	Nutrients	Siltation	Suspended Solids	Pesticides	Pathogens
Northeast	538,290	230,460	380	71,100	170,170
Appalachia	36,230	7,610	4,520	210	340
Southeast	14,000	0	216,700	24,910	35,890
Lake States	318,740	0	0	0	1
Corn Belt	253,770	235,240	195,610	76,990	8,910
Northern Plains	302,440	209,790	45,620	113,370	48,290
Delta States	260,310	190,530	6,930	197,620	274,080
Southern Plains	256,180	388,510	252,290	215,660	19,630
Mountain States	833,960	339,250	552,290	8,070	52,120
Pacific States	276,550	142,820	15,620	6,880	23,180
United States	3,222,660	1,744,220	1,228,970	715,560	635,430

Source: U.S. EPA 305(b) reports. 1992 as reported by the States and published in the "Water Quality and Agriculture: Status, Conditions, and Trends," USDA/NRCS, Working Paper #16, January 1996/

Concerning impairments of assessed estuaries, the following graph 3.2.2.c. uses data from the 1992 US EPA 305(b) reports:

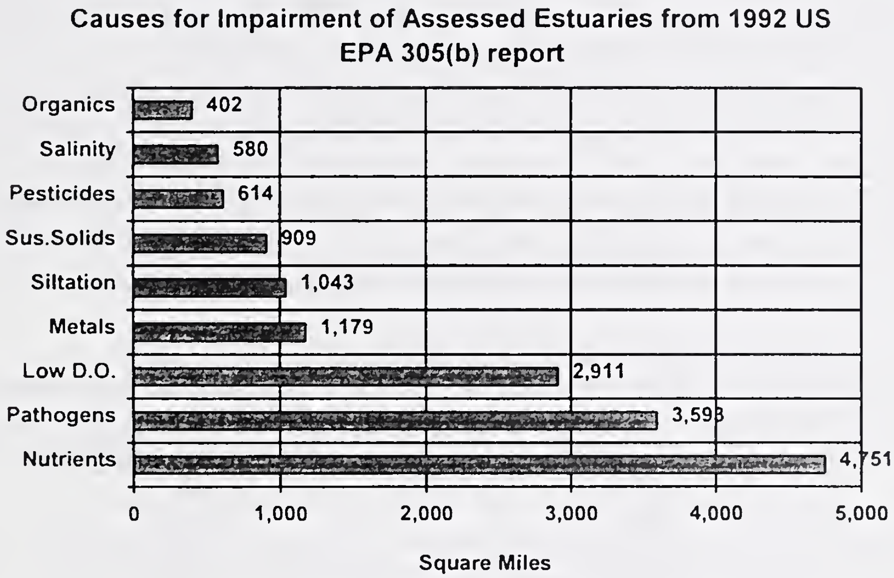


Table 3.2.2.g. provides overall national perspective and region specific details regarding impairment of estuaries. Nationally, approximately 18 percent of the assessed estuaries were impaired by nutrients, and 13 percent were impaired by pathogens. Nutrients are the priority concern within the Northeast and Delta States, while pathogens are the main cause of impairment within the Southern Plains and Pacific States. However, pathogens are also a major concern within the Northeastern States given than an estimated 21 percent of the assessed estuary area were reported contaminated.

Table 3.2.2.g	Principal Causes of Impairment in Estuaries from all Sources for Assessed Water, by Farm Production Region, 1990-1991. (Sq. Miles)					
Region	Nutrients	Pathogens	Siltation	Suspended Solids	Pesticides	Salinity
Northeast	3,000	1,540	850	60	100	0
Appalachia	480	220	0	230	250	0
Southeast	400	250	0	430	1	0
Delta States	880	640	190	190	190	580
Southern Plains	0	540	0	0	0	0
Pacific States	3	400	5	0	80	0
United States	4,750	3,590	1,040	910	610	580

Source: U.S. EPA 305(b) reports, 1992 as reported by the States and published in the "Water Quality and Agriculture: Status, Conditions, and Trends." USDA/NRCS, Working Paper #16, January 1996/

Chemigation, the irrigation application of pesticides and nutrients, is a concern because of possible excess nutrient loading of the aquifer. For each inch of deep percolation, 10 to 15 pounds of nitrogen per acre is leached into the water supplies. Additionally, research indicates that an average of 20 tons per acre per year of irrigation-induced erosion is common, while 50 tons per acre per year is not uncommon.

Table 3.2.2.h. provides projections for impairments resulting from agricultural sources. This table is noteworthy mainly in view of the regional and State level variability. For example, the Northern Plains and Delta States both reported impairment from agricultural sources on more than 70 percent of their assessed river and stream miles, while the Northeast reported less than 5 percent impaired by agricultural sources. The States with the highest reported impairment from agricultural sources were within the Lake States and Southern Plains region. These two regions reported the worst conditions in one State each where more than 90 percent of the assessed miles of rivers and streams were impaired by agricultural sources. Significant regional level and State variability is also observed with respect to the data displayed in the table for lakes, reservoirs, and ponds.

Table 3.2.2.h.	Agricultural Sources of Impairment for Assessed Areas by Farm Production Region, 1990-1991.	
Region	Rivers and Streams (miles)	Lakes, Reservoirs, and Ponds (acres)
Northeast	6,050	222,820
Appalachia	9,390	14,590
Southeast	3,;610	648,850
Lake States	3,600	0
Corn Belt	26,090	281,940
Northern Plains	31,170	213,830
Delta States	37,430	241,600
Southern Plains	4,170	388,800
Mountain States	19,130	938,160
Pacific States	16,400	139,870
United States	158,040	3,091,580

Source: U.S EPA 305(b) reports, 1992 as reported by the States and published in the "Water Quality and Agriculture: Status, Conditions, and Trends." USDA/NRCS, Working Paper #16, January 1996/

3.2.3 PESTICIDE, FERTILIZER AND HERBICIDE IMPACTS

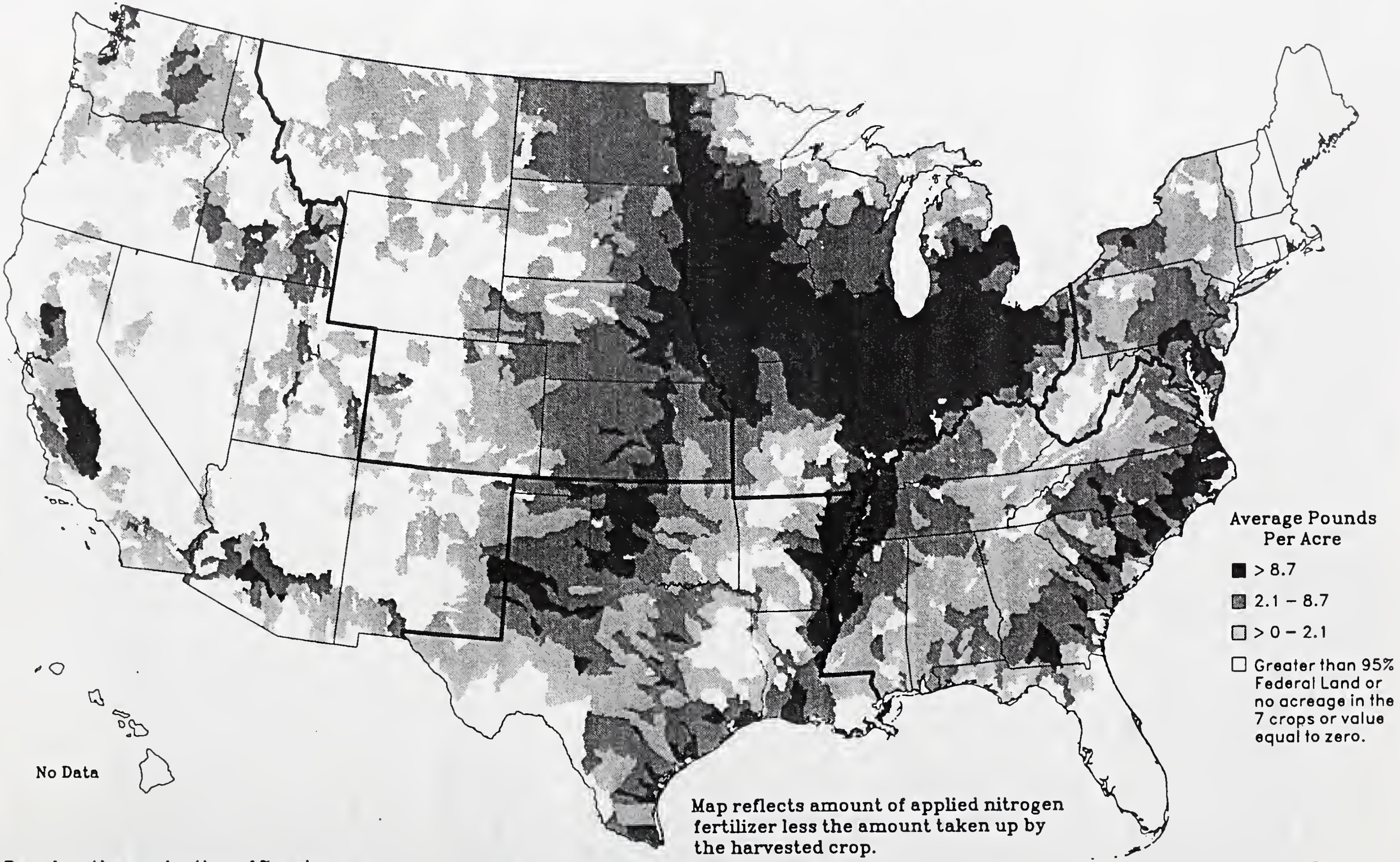
Although it is not possible to quantify the potential impacts of pesticides and fertilizer use on agricultural and related natural resource assessment endpoints on a national scale, the maps provide information on where the impacts from those risks are potentially the greatest. More specific information at the state and local level can help determine to what extent environmental damage is occurring from one or more of these stressors. To better illustrate the extent and location of agricultural impacts, the following maps illustrate the potential impacts from nutrient and pesticide application, and irrigation practices.

Map 3.2.3.a illustrates the Potential Nitrogen Fertilizer Loss from Farm Fields. Map 3.2.3.b illustrates the Potential Phosphate Fertilizer Loss from Farm Fields. The potentials for losses of both nitrogen and phosphate fertilizers from farm fields is greatest in the Corn Belt States (Iowa, Illinois, Indiana, and Ohio), as well as those areas of Missouri, Tennessee, Arkansas, Mississippi, and Louisiana in the Mississippi River Delta areas. Potentially high nitrogen losses can also occur in Minnesota and eastern Nebraska. These losses are especially significant because of the types of soils, and the magnitude of agricultural activities. For the most part, the soils in the Mississippi River drainage area are loamy in nature, and as such, fertilizer particles easily adhere to the soil structure. The loamy soil textures are also susceptible to water erosion, acting somewhat like sugar when exposed to water. As the soil particles detach, fertilizer particles are transported to other locations, some potentially as far away as the Gulf of Mexico. As nutrient-enriched sediment enters ground and surface waters, including the Gulf of Mexico, oxygen depleted zones can be created, especially during the hot, summer, months. Other areas of high potential losses include the California's Central Valley. Potentials for high phosphate losses additionally includes North Dakota and the Texas Panhandle area. Phosphorus tends to build up in soils through adherence to the clay particles. Both nitrogen and phosphorus particles can move from farm fields into surface and groundwater sources.

Maps 3.2.3.c and 3.2.3.d illustrate areas with a high potential for environmental damages due to pesticides runoff or leaching. These areas include the Central Valley of California, Iowa, Illinois, Indiana, and Ohio, the Mississippi Delta region, Florida, western Georgia, North and South Carolina, and the Chesapeake Bay Area.

Areas most susceptible to pesticide leaching include the eastern Great Plains, the Midwestern States, the Ohio and Tennessee Basins, the Atlantic Coast from eastern North Carolina to south Georgia, the lower Mississippi Basin, the Chesapeake Bay area, New York State, and Pennsylvania. Areas that would be susceptible to environmental damages from herbicide applications are the Midwestern States, the Upper Mississippi Basin, and the Mississippi Delta Region. This information is particularly useful in identifying needed new conservation technology in the improvement of pesticide and herbicide management programs. Wildlife, both avian and terrestrial, are especially sensitive to pesticides and insecticides. The Midwestern States, as well as those states in the Mississippi River drainage basin, have some of the most important habitat areas, from the standpoint of avian species. The Mississippi Flyway, as well as

Potential Nitrogen Fertilizer Loss From Farm Fields

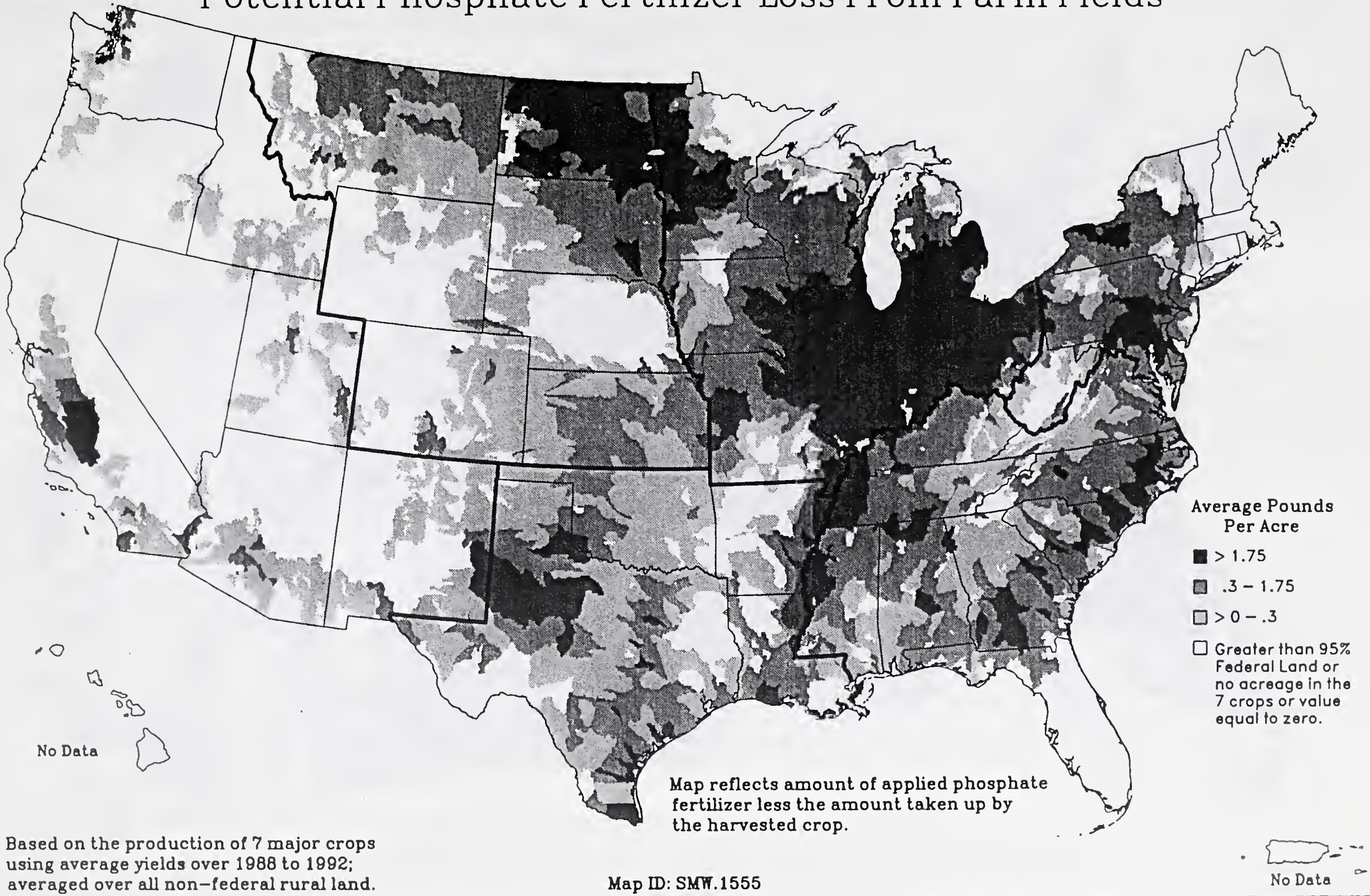


Map reflects amount of applied nitrogen fertilizer less the amount taken up by the harvested crop.

Based on the production of 7 major crops using average yields over 1988 to 1992; averaged over all non–federal rural land.

Map ID: SMW.1554

Potential Phosphate Fertilizer Loss From Farm Fields

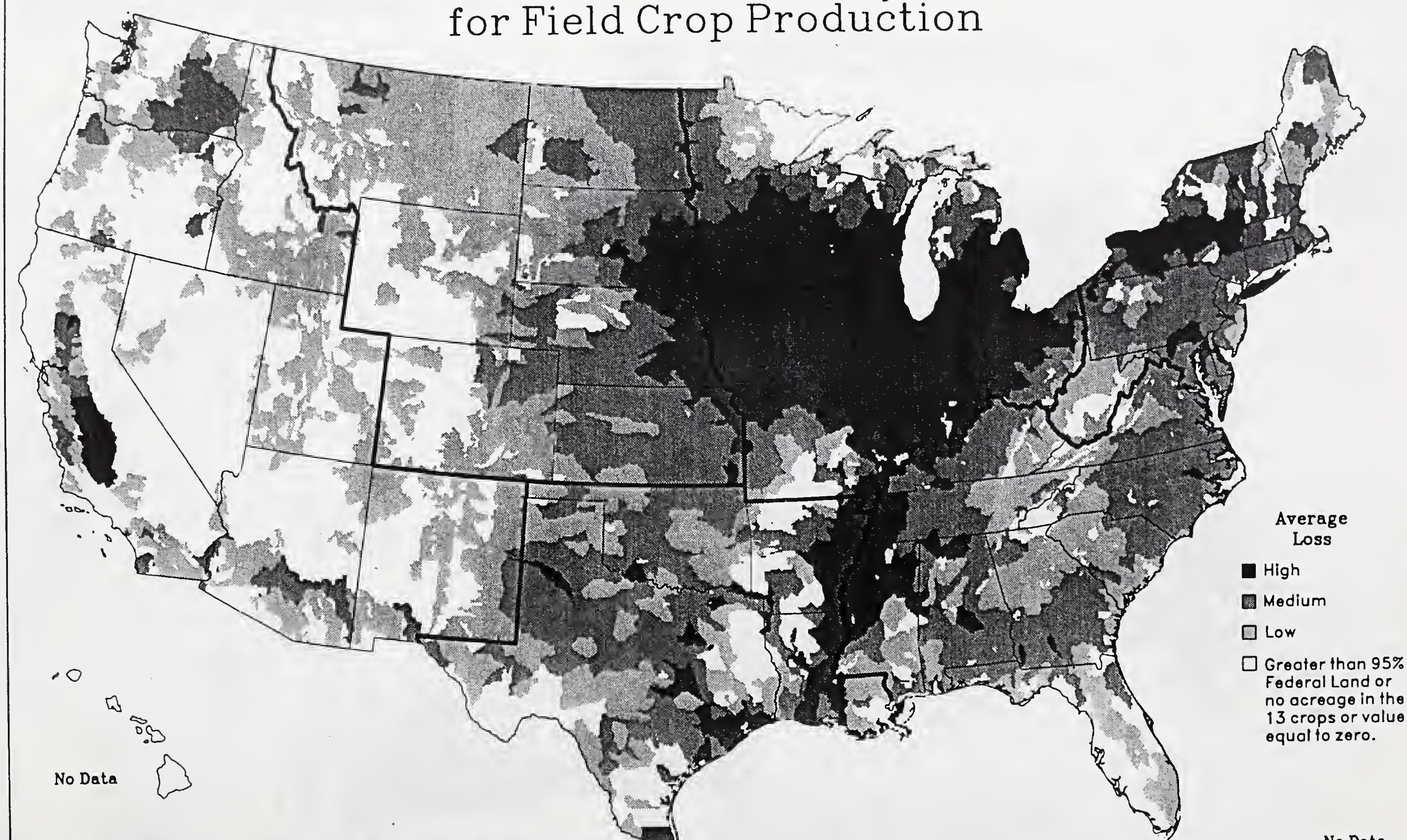


Map reflects amount of applied phosphate fertilizer less the amount taken up by the harvested crop.

Based on the production of 7 major crops using average yields over 1988 to 1992; averaged over all non-federal rural land.

Map ID: SMW.1555

Pesticide Runoff Potential by Watershed for Field Crop Production

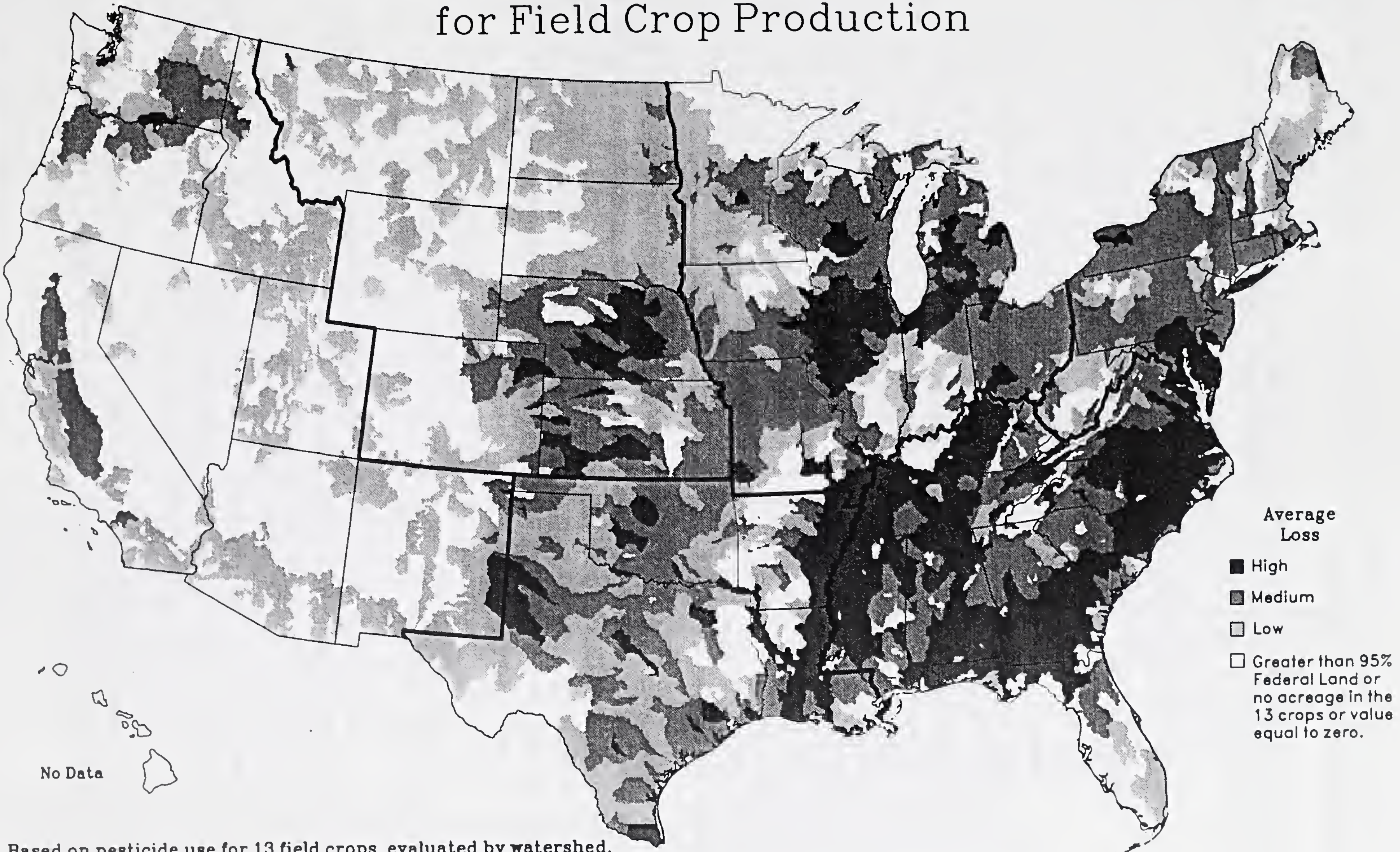


Based on pesticide use for 13 field crops, evaluated by watershed, and averaged over all non-federal land. Pesticide losses were simulated using the GLEAMS model and national data on land use, chemical use, soils, and climate.

Map ID: SMW.1662

Note: Includes dissloved and adsorbed pesticides

Pesticide Leaching Potential by Watershed for Field Crop Production



Based on pesticide use for 13 field crops, evaluated by watershed, and averaged over all non-federal land. Pesticide losses were simulated using the GLEAMS model and national data on land use, chemical use, soils, and climate.

Map ID: SMW.1663

the Central Flyway in the Great Plains, provide food and shelter for a large number of wildlife, and threatened and endangered species.

Nine major herbicides and six major pesticides account for 85 percent and 73 percent respectively of the active ingredients used on field crops. Table 3.2.3.a shows these ingredients, and rates for 1993.

Table 3.2.3.a Herbicide and Insecticide Active Ingredients Used on Field Crops, 1993

Active Ingredient	Pounds Applied (x 1,000)
2,4-D	11,620
Alachlor	40,220
Atrazine	49,550
Butylate	5,440
Cyanizine	28,100
EPTC	12,130
Metolachlor	46,440
Pendimethalin	14,700
Trifluralin	16,530
Carbofuran	1,250
Chlorpyrifos	6,610
Fonofos	1,940
Methyl parathion	5,050
Phorate	2,580
Terbufos	5,560

Source: USDA, ERS, Cropping Practices Survey data.

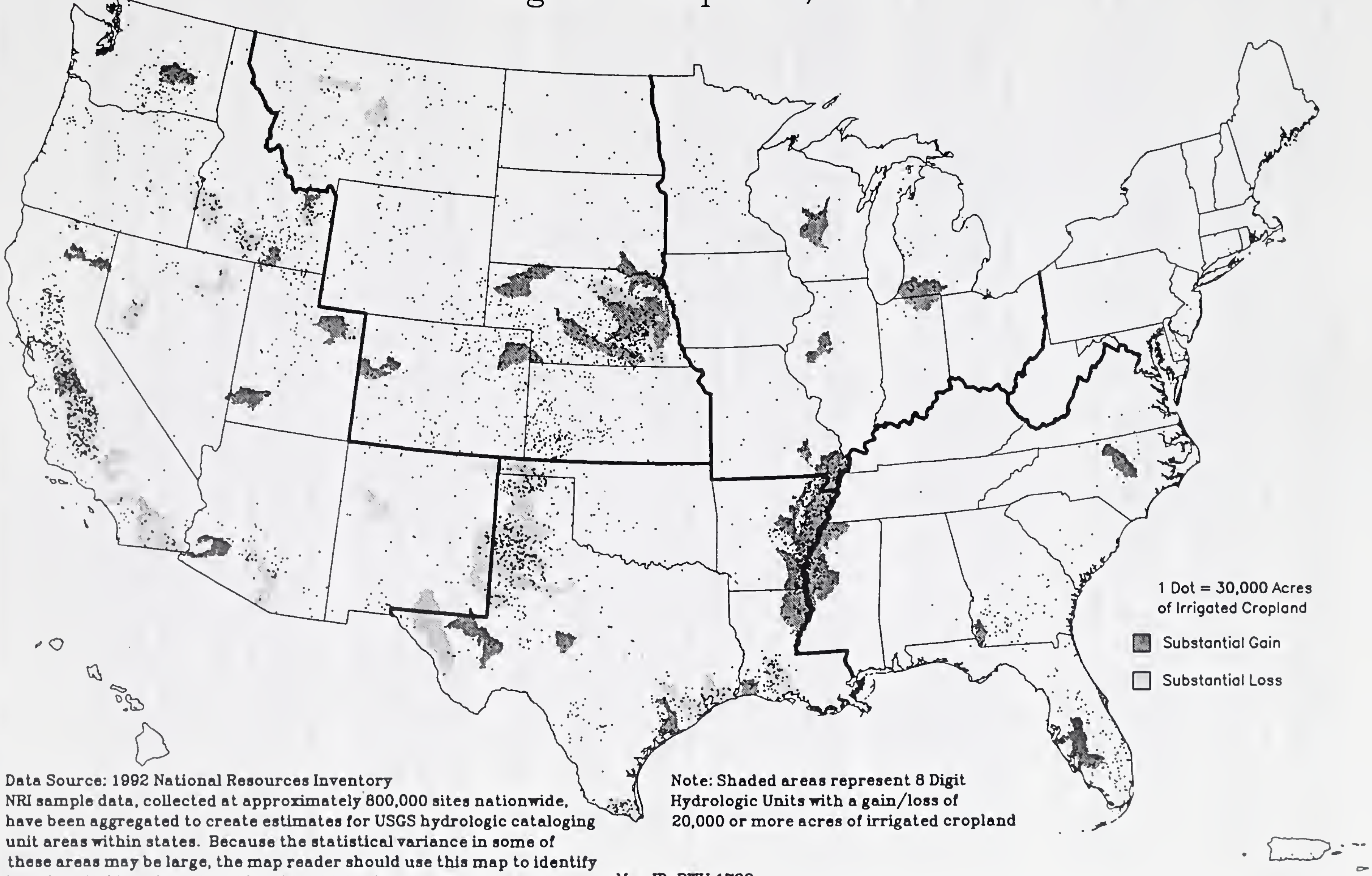
Areas most susceptible to environmental risk due to insecticides include: the Midwestern States, the Upper Mississippi Basin, the Texas and Oklahoma Panhandle areas, southwest Kansas, eastern Nebraska, the Mississippi Delta region, and the Atlantic Coast area of Georgia, South and North Carolina, Virginia, Maryland, and Delaware, and California's Central Valley. As with herbicides, the areas at most risk are those providing habitat for avian and terrestrial wildlife, and threatened and endangered species.

3.2.4 IRRIGATION IMPACTS

Map 3.2.4.a provides a generalized location for areas potentially impacted due to irrigation practices. Areas associated with irrigation-induced environmental problems are primarily located in the western United States, southern Florida, Georgia, and the rice production areas of Arkansas, southern Texas, and Louisiana. Areas primarily utilizing pressure irrigation are in the States of Nebraska, Kansas, eastern Colorado, New Mexico, western Oklahoma, and portions of Texas, and Louisiana. Most of Florida utilizes pressure irrigation. Also, there are isolated areas along the east coast from Georgia to southern Maine plus the Pacific Northwest and California.

Groundwater overdrafting has been recorded in the following States: Nebraska, Kansas, Colorado, Oklahoma, New Mexico, Texas, California, Arizona, Idaho, Arkansas, Florida, and

Irrigated Cropland, 1992



Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Note: Shaded areas represent 8 Digit Hydrologic Units with a gain/loss of 20,000 or more acres of irrigated cropland

Map ID: RWH.1732

Georgia. Water table declines have been recorded in Idaho, Texas, and Kansas that exceed 4 feet annually. Continuous and sustained overdrafting eventually results in exhaustion of economically available groundwater reserves. Irrigation consumptive usage accounts for about 96 percent of the national total 85 million acre-feet groundwater usage. (Source: Agricultural Handbook 705.)

Areas where gravity irrigation methods are used include the Colorado River Basin, the Great Basin area, the Pacific Northwest, the Rio Grande River Basin, parts of the Texas Gulf Coast, and parts of the northern Great Plains in Nebraska, eastern Wyoming, western North and South Dakota, and portions of Montana.

Wells or ponds are sources of irrigation water in the Colorado Basin, the Rio Grande Basin, and California's Imperial Valley. A combination of wells, ponds, streams, ditches, and canals are primarily utilized throughout the Great Plains area, and the eastern Arkansas rice areas. Areas from Florida along the East Coast to southern Maine utilize streams, ditches, or canals as primary sources of irrigation water.

Salinity impairments currently exist in approximately 26,430 miles of the Nation's streams, primarily in the Northern Plains and Mountain States. Ecological responses, or effects as a result of increased salt loadings include the increase of selenium leachate, which when induced into the irrigation return flows becomes toxic to wildlife, especially migratory waterfowl. Also, increased salt loadings in irrigation return flows cause ecological damages through salt and selenium toxicities to sensitive wetland and riparian areas leading to decreased habitat for many species, some of which are on the threatened and endangered species lists.

3.3 GRAZING LAND AND LIVSTOCK RESOURCES

3.3.1 RANGELEND AND PASTURELAND

The limited availability of soil moisture is the greatest natural stressor for the majority of the Nation's rangeland resources. This stressor has shaped the natural plant communities that make up this resource. The response that these communities exhibit to the various stressors will vary depending on the current availability of moisture.

Limited moisture results in reduced: vegetative production, carbon dioxide conversion, production of food and forage for wildlife and livestock, and plant cover. Any reduction in cover may lead to increased soil erosion, resulting in increased sediment deposition, and decreased water quality and quantity, depending on the soil and plant conditions.

Table 3.3.1.a provides an overview of range conditions and trends on both public and private lands. As indicated, most rangelands are categorized as either in good or fair condition, with 16 to 18 percent of all public and private lands in poor condition. However, almost as much private

rangeland is in a downward condition trend as is in an upward improvement trend, with 70 percent not improving or getting worse. Map 3.3.1.a indicates Rangeland Status as of 1992.

Table 3.3.1.a Summary of Range Conditions and Trends for Public and Private Lands, 1989

Range Condition	Agency Lands Covered (percentage)		
	Forest Service[1]	Bureau of Land Management[1]	Natural Resources Conservation Service[1]
Excellent	3	4	4
Good	36	30	30
Fair	44	41	45
Poor	16	18	16
Other	--	7	5

Range Trend	Forest Service	Bureau of Land Management	Natural Resources Conservation Service
Upward	43	15	16
Downward	13	14	14
Static	43	64	70
Undetermined	--	6	--

Source: Society for Range Management (1989) as reported on page 149 in "America's Renewable Resources - Historical Trends and Current Challenges." Resources for the Future, Kenneth d. Frederick and Roger A. Sedjo. Editors. 1991.

Note: columns may not total 100 percent due to rounding.

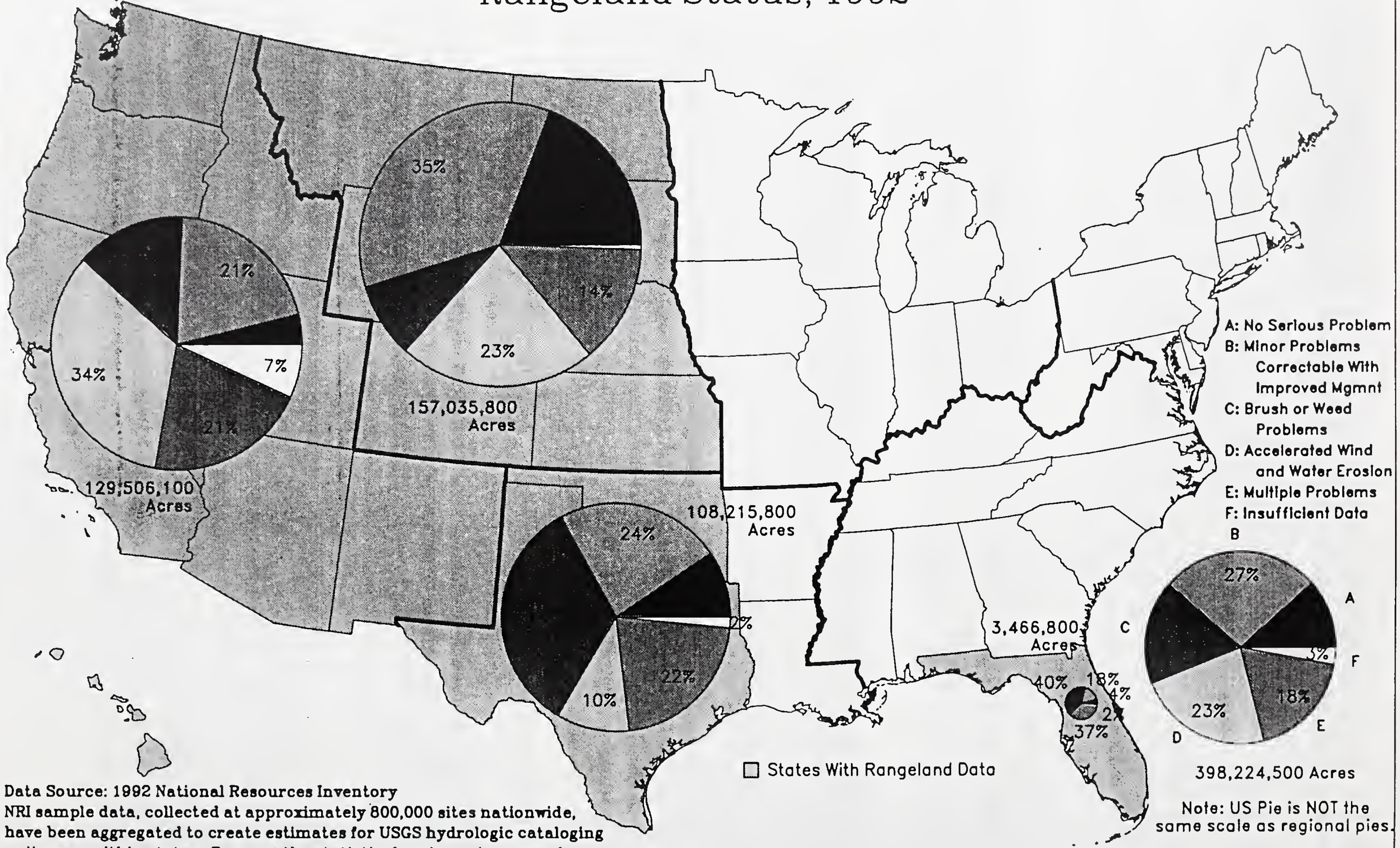
Map 3.3.1.b shows pasturelands that need conservation treatments in the lower 48 States as of 1992. The priority areas for pasture and hayland treatment are located in the southern US, primarily eastern Texas, western Arkansas, southeastern Missouri, central Kentucky, middle Tennessee, western Virginia and North Carolina, portions of Alabama and Mississippi, central and southern Florida, southern Ohio, western Pennsylvania, and northern West Virginia.

3.3.2 LIVESTOCK

Table 3.3.2.a gives livestock concentrations by animal unit per State. Areas with the highest potentials for environmental risk from animal waste problems are the Pacific Northwest and the Southeastern United States. The Northeast, parts of Minnesota and Wisconsin, Idaho, California, New Mexico, Texas, and Oklahoma have moderate potentials for environmental risks.

Locations of environmental concerns associated with dairy cattle and milk production are in the Midwestern and Northeastern Regions of the United States. Primary dairy States are Wisconsin and the southern half of Minnesota, northwest and northcentral Ohio, southern Michigan, northern Illinois, and Indiana, New York State, New Hampshire, Rhode Island, Connecticut, Pennsylvania, New Jersey, Delaware, and Maryland. States that have a potential for moderate levels of environmental problems for dairy cattle and milk production are California, Washington, portions of Idaho and Utah, central Kentucky, middle and upper east Tennessee, western Virginia, and western North Carolina

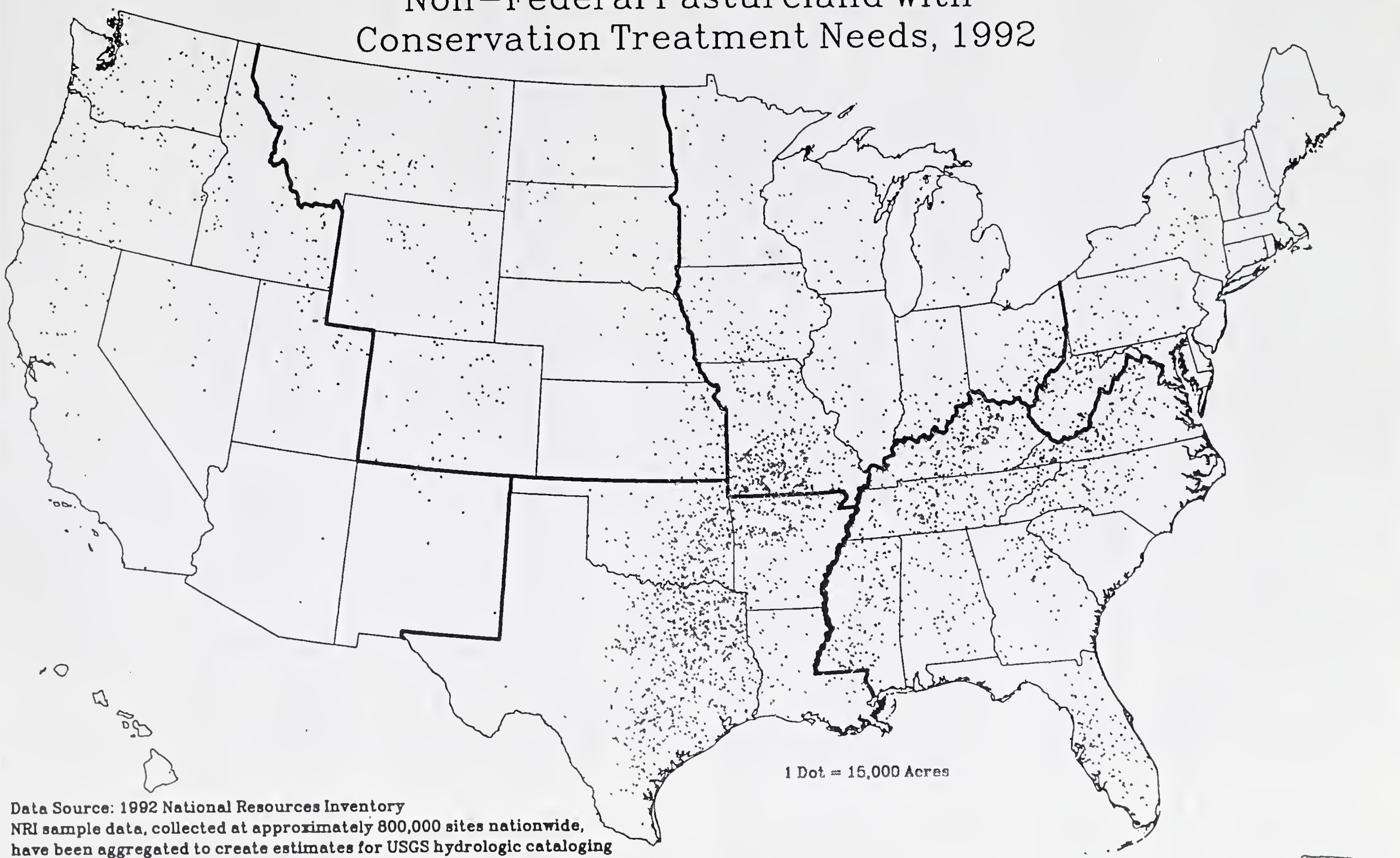
Rangeland Status, 1992



Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Map ID: RWH.1657

Non-Federal Pastureland with Conservation Treatment Needs, 1992



Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Map ID: RWH.1879

Confined livestock are primarily located in the Southeastern and Midwestern regions of the United States, with the exception of feedlot beef cattle, that for the most part, is located in the Great Plains Region. Areas with environmental problems associated with beef cattle production are: northern Texas, western Oklahoma, Kansas, northeastern Colorado, eastern and southcentral Nebraska, Iowa, and northern Illinois. Indiana, Ohio, central Washington State, southwest Arizona, and the central valleys of California exhibit a potential for a moderate level of environmental problems related to the production of beef cattle.

Major hog producing States are located primarily in the Midwestern States of Iowa, eastern Nebraska, northern Missouri, western Illinois, Indiana, and western Ohio. Southeastern States with a lesser extent of hog production are southwestern Kentucky, middle Tennessee, north Alabama, western North Carolina, and southeast Georgia.

The largest share of poultry production and associated environmental problems is concentrated in the Southeast and New England States as follows: Arkansas, southern Mississippi, northern Alabama, Georgia, northern Florida, northwestern North Carolina, southern Maine, Connecticut, New Jersey, Maryland, and Delaware. Other States with the potential for moderate levels of environmental problems related to chicken production include California's Central Valley and the Puget Sound area of Washington State. Broiler production areas are primarily located in the Southeastern Region, especially northern Georgia and Alabama, western Arkansas, southcentral Louisiana, western North Carolina, Tennessee, and Kentucky. Additional areas of broiler production include the Central Valley of California, southern Maine, and Maryland.

3.4 WETLAND RESOURCES

The Nation's remaining wetland resources currently are less than half the wetlands that previously existed. Over the period 1982 to 1992, agriculture's contribution to total wetland losses declined, from more than 87 percent in the mid-1950's, to an estimated 19.8 percent in 1992. Fifty-six percent of the overall losses in 1992 were attributable to urban development. Additionally, since 1992, 400,000 acres of wetlands have been restored through the Wetland Reserve and other applicable programs. Table 3.4.a shows, by farm production region, the extent of the Nation's palustrine wetlands.

The majority of this wetland type is located in the Lake States, the Southeast States and the Delta States. The majority of the losses of this wetland type occurred in the Appalachian and Southeastern States. Maps 3.4.a, 3.4.b, and 3.4.c illustrate the extent of wetlands and deep water habitats in the United States. While overall losses of wetlands attributable to agriculture have been decreasing over the last 10 years, these environmentally sensitive areas are continuously being impacted by agricultural production, and the bi-products of crop and livestock production activities.

Table 3.3.2.a

ANIMAL UNITS (x1,000)

STATE	BEEF	DAIRY	HOGS	POULTRY	STATE	BEEF	DAIRY	HOGS	POULTRY
Alabama	904.7	70.7	41.7	347.8	Montana	1980.5	34.8	29.1	2.8
Alaska	3.9	1.1	0.3	0.0	Nebraska	4159.1	129.5	579.4	41.0
Arizona	512.4	137.7	12.5	1.7	Nevada	329.2	33.8	1.8	0.1
Arkansas	1016.8	100.2	105.8	595.5	New Hampshire	11.3	33.7	0.1	1.3
California	1967.2	1941.8	37.7	415.6	New Jersey	22.8	37.2	3.6	7.3
Colorado	2226.8	127.2	66.7	47.3	New Mexico	1059.0	171.7	3.3	4.8
Connecticut	18.3	53.7	0.8	16.7	New York	303.2	1121.3	12.5	21.6
Delaware	10.1	13.5	9.0	92.7	North Carolina	492.2	154.4	698.5	658.0
Florida	1076.1	266.9	16.6	78.9	North Dakota	1140.6	116.4	46.5	12.0
Georgia	749.2	158.6	144.0	414.6	Ohio	545.9	459.7	276.2	145.4
Hawaii	104.5	16.8	4.4	3.7	Oklahoma	3459.1	140.4	36.9	85.1
Idaho	1200.6	282.6	9.1	5.2	Oregon	932.7	154.0	8.1	25.5
Illinois	877.3	235.5	791.1	34	Pennsylvania	455.2	971.9	147.1	212.9
Indiana	540.5	224.7	651.3	183.2	Rhode Island	1.8	4.0	0.7	0.8
Iowa	2351.2	402.5	1944.4	114.1	South Carolina	262.2	49.6	48.5	95.8
Kansas	4702.8	132.4	220.5	12.8	South Dakota	2480.9	182.6	273.0	27.4
Kentucky	1506.6	289.3	111.4	22.4	Tennessee	1254.6	236.4	89.5	47.1
Louisiana	503.5	122.8	5.7	54.2	Texas	9221.1	613.4	66.3	264.9
Maine	26.3	66.4	0.8	21.7	Utah	514.5	124.9	5.7	36.8
Maryland	95.0	147.3	21.2	123.6	Vermont	58.9	261.9	0.7	0.8
Massachusetts	18.2	48.1	2.3	3.0	Virginia	949.9	217.7	55.9	226.6
Michigan	354.3	492.7	180.7	64.1	Washington	675.0	377.4	7.9	33.6
Minnesota	979.1	946.8	649.6	348.2	West Virginia	283.9	36.3	3.8	56.4
Mississippi	727.3	100.3	23.1	181.8	Wisconsin	877.6	2366.1	162.6	61.2
Missouri	2648.3	335.7	419.4	185.5	Wyoming	1058.8	11.8	4.9	0.1

	BEEF	DAIRY	HOGS	POULTRY
US TOTALS	57650.4	14756.1	8033.2	5437.4

Table 3.4.a Status of Palustrine Wetlands in the United States, 1982 to 1992

Region	1982 Acres (x 1,000)	1992 Acres (x 1,000)	Change (Gain/Loss) Acres (x 1,000)
Northeast	14,010	13,870	- 140
Lake States	22,220	22,050	-170
Corn Belt	5,030	5,000	-30
Northern Plains	7,620	7,610	-10
Appalachia	7,760	7,420	-340
Southeast	21,490	21,200	-290
Delta States	15,300	15,260	-40
Southern Plains	5,030	5,010	-20
Mountain States	4,230	4,260	+30
Pacific States	3,120	3,090	-30
United States	105,810	104,770	-1,040

The majority of the wetlands and deep-water habitats are located in the Southeastern United States, primarily southern Arkansas, eastern Texas, west Tennessee and Kentucky, Mississippi, Alabama, Georgia, Florida, eastern South and North Carolina, and eastern Virginia. Other States with a large number of wetlands and/or deep-water habitats include Washington, North Dakota, eastern South Dakota, Minnesota, Wisconsin, northern Michigan, northern New York, and New England.

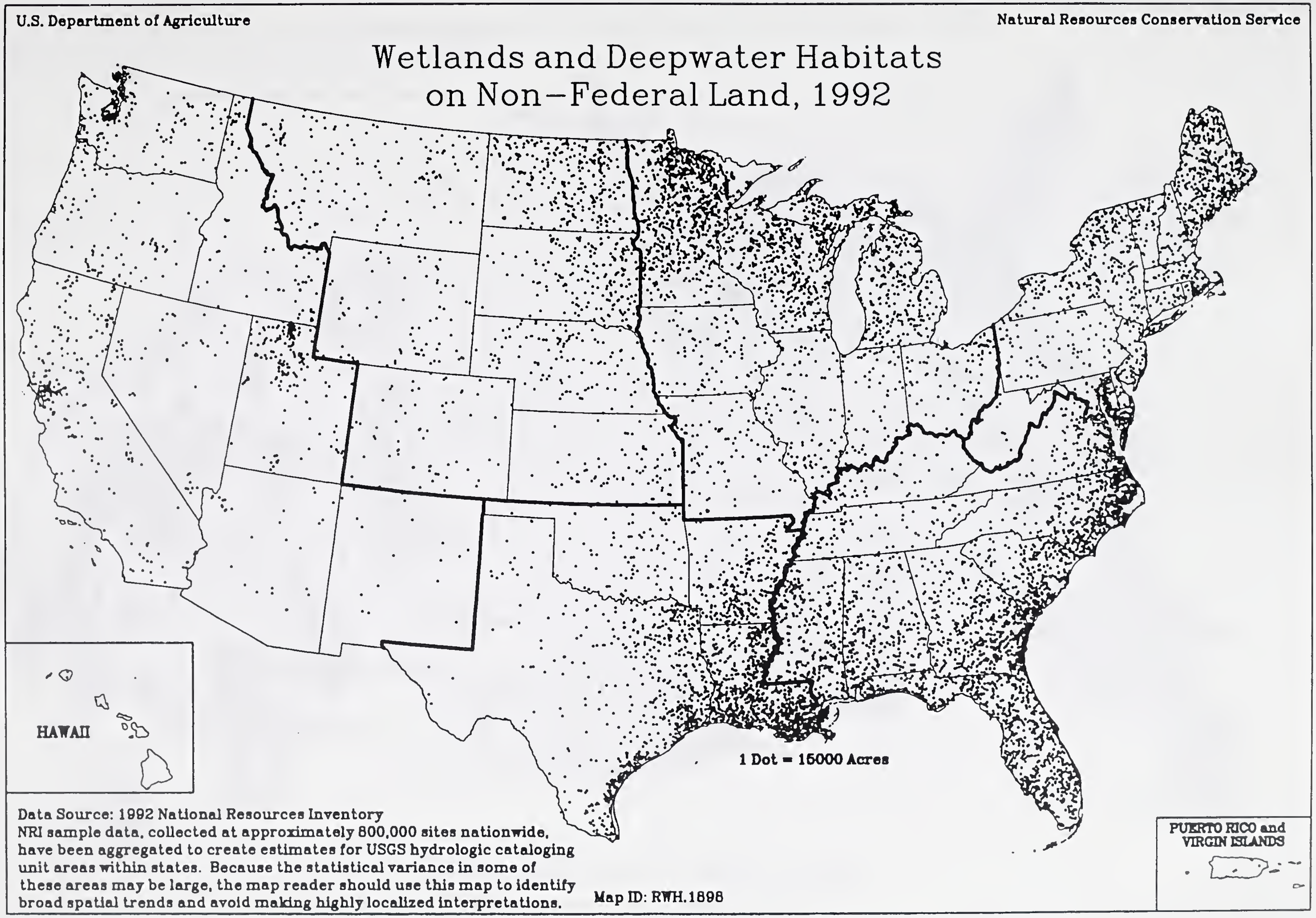
Areas of major environmental concern about wetlands and/or deep-water habitats include California's Central Valley, the Palouse area of eastern Washington, Idaho, and Oregon, the Dakotas, the Midwestern States, south Texas, the Mississippi Delta region, the Tennessee Basin, Alabama, south Florida, South Carolina, the Chesapeake Bay Region, and southern New York State. Areas of environmental risk from cropland with occasionally-to-frequently flooded soils include California's Central Valley, the eastern Great Plains Area, the Midwest, the southern Great Plains, the Ohio, Tennessee, and Cumberland River Basins, the Chesapeake Bay Area, southern New York State and portions of Vermont, New Hampshire and Maine.

A comparison of the wetland maps with those delineating areas of potential pesticide, herbicide, and fertilizer losses would be helpful in directing EQIP decisionmakers in distinguishing where the greatest potential for impact exists from a particular stressor.

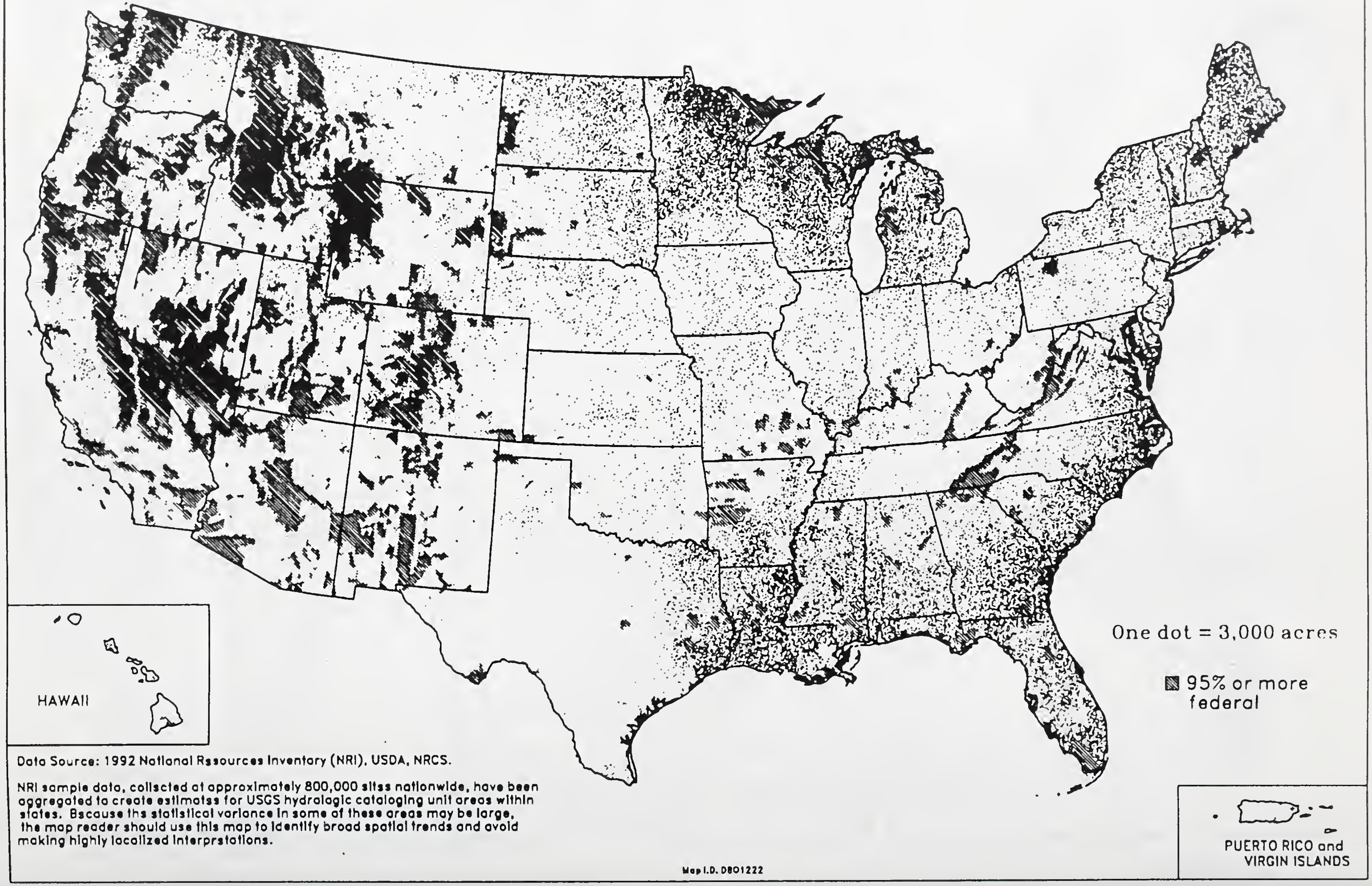
3.5 WILDLIFE HABITAT RESOURCES

As of June 1995, there were 631 Federally listed threatened and endangered species in the continental 48 States, including 357 animals and 274 plants. More than half of these listed species are generally associated with land-based habitats, about a third are associated with fresh-water habitats, and 10 percent are found in estuaries and other coastal habitats. Only 2 percent are associated with the oceans.

Habitat loss and alteration, especially fragmentation, are the main causes for habitat degradation. The number of species being added to the list of threatened and endangered species has grown at an average rate of 34 new species per year since 1980, but more significantly the number of


U.S. Department of Agriculture
Natural Resources Conservation Service
Wetlands and Deepwater Habitats on Non-Federal Land, 1992
HAWAII
1 Dot = 15000 Acres
PUERTO RICO and VIRGIN ISLANDS
Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.
Map ID: RWH.1898

Palustrine Wetlands, 1992



Data Source: 1992 National Rasources Inventory (NRI), USDA, NRCS.

NRI sample data, collsctad at approximately 800,000 sitss nationwide, have been aggregated to create estimatss for USGS hydrologic cataloging unit areas within states. Bscause ths statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interprstations.

Map I.D. D801222

U.S. Department of Agriculture

Palustrine Wetlands on Cropland, 1992

Natural Resources Conservation Service

One dot = 3,000 acres

In this analysis Cropland includes Conservation Reserve Program (CRP) Land

Data Source: 1992 National Resources Inventory
NRI sample data, collected at approximately 800,000 sites nationwide, have been aggregated to create estimates for USGS hydrologic cataloging unit areas within states. Because the statistical variance in some of these areas may be large, the map reader should use this map to identify broad spatial trends and avoid making highly localized interpretations.

Map I.D. DBO.1200

candidate species has remained more than 3,500 since the mid-1980s. The threat of extinction is a very real possibility for many of these species. The geographic distribution of the threat is pervasive, although the largest number of threatened and endangered species are found in peninsular Florida, the Atlantic and Gulf coasts, the southern Appalachians, and in the arid southwest. Agricultural development is the main reason identified for endangerment for 262 species. Agriculture is listed as a factor for an additional 159 species. Urban development is also a primary cause for species endangerment.

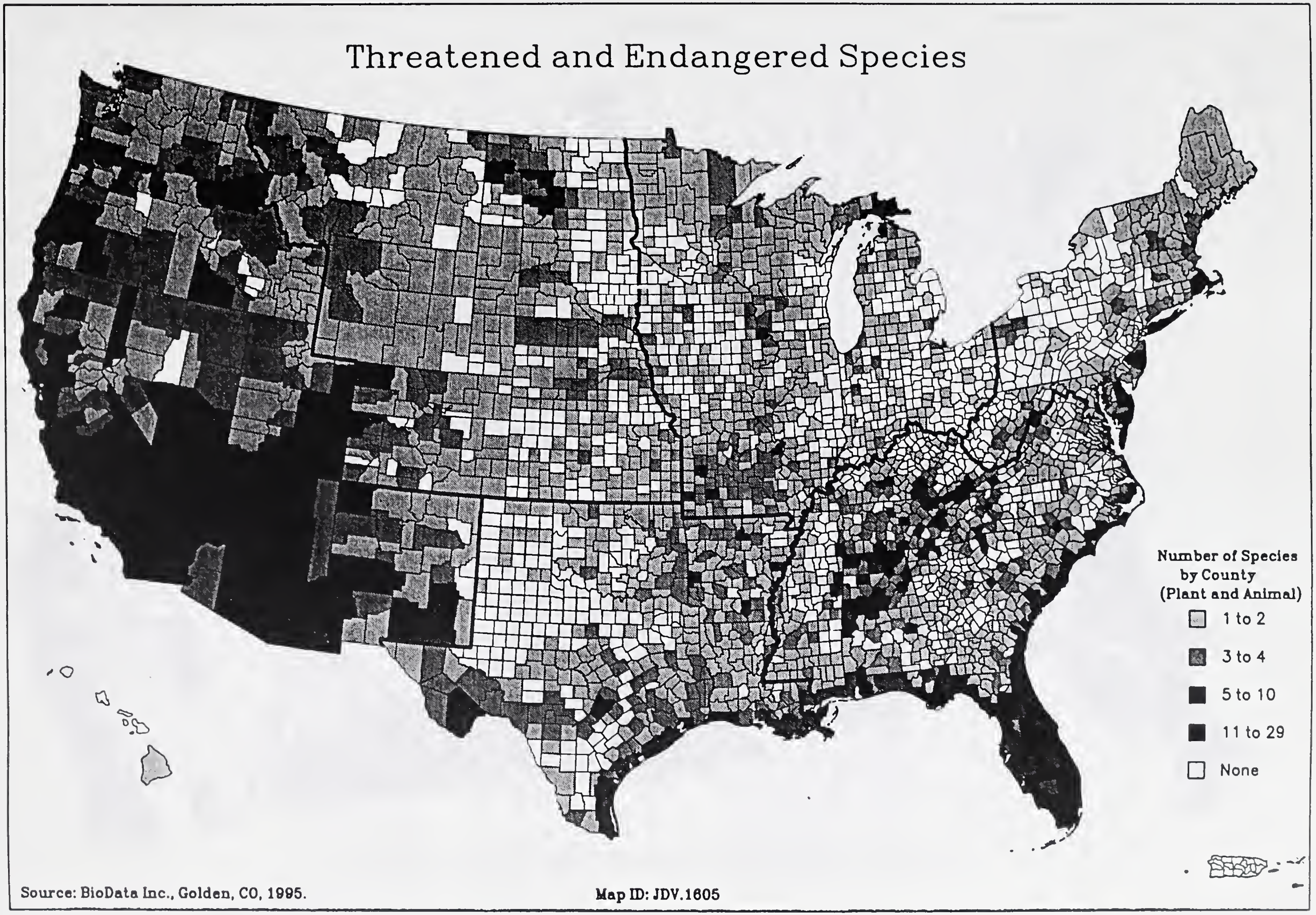
A focus on the number and dispersion of threatened and endangered species fails to communicate the significance of this issue from an ecological systems context. (See Map 3.5.a, Threatened and Endangered Species.) The importance of many of these species is unknown with respect to the functions they perform in our ecological communities, but many are known to serve vital life-supporting roles. In addition, many threatened and endangered plant species are known sources of pharmaceutical ingredients, or provide the means for development of new drugs based on the study of them. Many other threatened and endangered plant species have either wholly or largely unknown pharmaceutical potential. Lastly, the cumulative effects of lost species on the broader environment are largely unknown.

Map 3.5.b shows priority waterfowl areas as defined by the US Fish and Wildlife Service. Primarily, the map shows the Eastern, Mississippi, Central, and Western Flyways or migratory routes of a variety of waterfowl species. It also shows some of the major wintering and breeding areas for endangered or threatened species, including the Whooping Crane. On a National scale, there is little to no information available to indicate the magnitude and spatial extent of impacts to these resources. Impacts can better be assessed at the local and State levels of NRCS.
A comparison of the threatened and endangered species maps, as well as the map delineating important wildlife habitats, with those delineating areas of potential pesticide, herbicide, and fertilizer losses would be helpful in directing EQIP decisionmakers in distinguishing where the greatest potential for impact exists from a particular stressor.

4. RISK CHARACTERIZATION

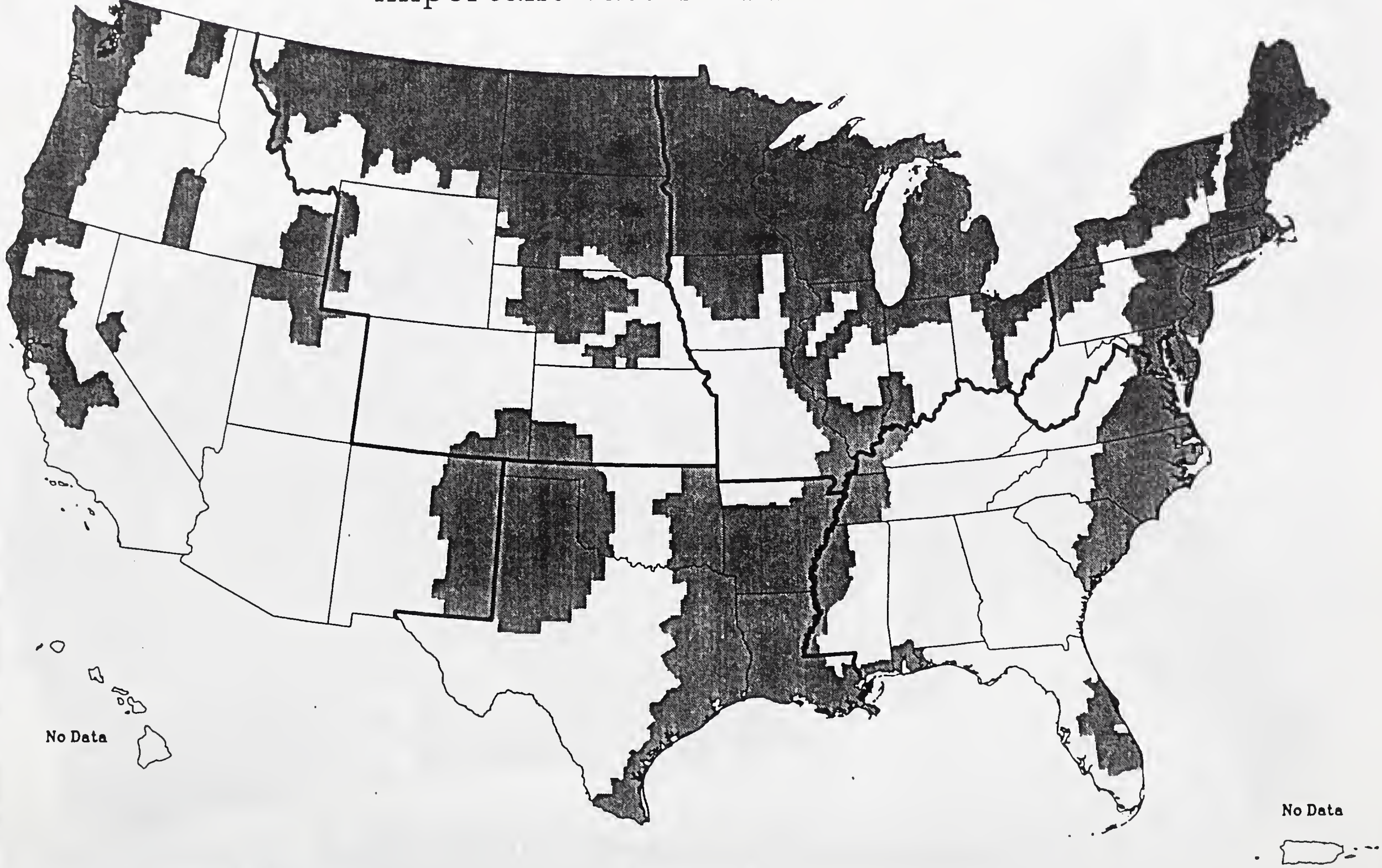
This section presents information that may be useful in making decisions about the Environmental Quality Incentives Program (EQIP) alternatives in relation to the environmental risks that have been illustrated. EQIP as a new program offers the opportunity to refocus natural resource efforts to concentrate on those resources that may be in need of assistance to maintain sustainable ecosystems and agroecosystems. Additionally, Congress instructed USDA to develop a program that maximizes environmental benefits per dollar spent, so the program must have a heavy emphasis on environmental enhancements to satisfy the intent of Congress.

This Risk Characterization identifies the magnitude of environmental consequences and delineates how those consequences can be addressed by proven on-farm conservation strategies. Quantitative information will be included, where appropriate and available, to describe effects of


Threatened and Endangered Species
Number of Species
by County
(Plant and Animal)
1 to 2
3 to 4
5 to 10
11 to 29
None
Source: BioData Inc., Golden, CO, 1995.
Map ID: JDV.1605

Map 3.5.b

Important Waterfowl Habitat Areas



Source: U.S. Fish and Wildlife Service, 1996.

Map ID: JDV.1625

alternatives and the possibilities for remediation, amelioration, or correction of the environmental problem.

4.1 RECOVERY-TIME SCALES

Realistically, ecological recovery time scales must be measured in years and decades. Thus, in this era of the condensed policy "sound bites," instantaneous access to world-wide Internet communications and fast-food appetite satisfaction, nature still operates in time frames that have existed for millions of years. While certain ecological processes can be "hurried up," others do not respond to prodding by humankind. These realities must be recognized in any discussion of ecosystem enhancement. Unfortunately for the scientists, technicians, and conservationists involved in making conservation enhancements work on an ecosystem scale, too many people want to see instantaneous results for the "natural works" as well.

There are some notable exceptions to the above thesis. Even though it has been 25 years since the passage of the Federal Water Pollution Control Act Amendments, the public still actively supports improvements to water quality. Air quality is supported by the public because no one wants to "see" polluted air. Therein lay the dilemma for conservationists/environmentalists. When the public can "see" changes brought about by conservation enhancements, even if over long time periods, the public will support those efforts. However, with the long time frames for ecological improvement and when environmental improvements are "unseen" or "not-seeable," public support can wane quickly.

As far as EQIP is concerned, ecological recovery time frames must be measured in years and decades, that poses the same dilemma as illustrated above. Nevertheless, EQIP as a new program can make significant progress in addressing conservation/environmental problems, especially on an ecosystem scale. The latter concept is particularly important as it pertains to EQIP because unfortunately in the past, many conservation programs were implemented with little regard to overall ecosystem effects. The result was that in many cases individual farmers or ranchers realized individual conservation gains, while there were some overarching conservation negatives to the ecosystem at large in which the farms or ranches were located.

With proper administration and implementation EQIP can address both onsite and offsite local and overall ecosystem needs simultaneously, but the keys to doing so are: recognition of the long-term recovery rates that operate ecologically; including inputs from all publics involved in the process, even those persons with adamantly opposing views to "prevailing thought"; and concentrating dollars in those areas where the greatest ecological gains can be made, even if all areas cannot receive some form of treatment.

4.2 CHRONICLE OF UNCERTAINTIES

Agricultural land use and the associated environmental effects are extremely interdependent with very complex chains of cause-and-effect relationships. Complicated feedback mechanisms and

buffering characteristics are also inherent in natural systems. Time lags between land use actions and manifestation of either positive or negative effects can be very long and often result from cumulative effects of a multiplicity of land users.

In addition, non-agricultural point and nonpoint sources of environmental pollutants intermingle with nonpoint sources from agricultural sources resulting in an extremely complex set of human and environmental actions and consequences with their intricate linkages. The uncertainty associated with the influences of weather and market forces, acting alone or in concert, cause decision-making by agricultural land users to be extremely unpredictable. The decisions are variable, dynamic, and complex on an individual scale, if not on a national scale.

Where appropriate and possible, the team has brought the latest and best-available information and data to bear on the EQIP issues at hand. However, since this risk assessment represents a major national environmentally oriented agricultural program, it was necessary in this report to "average" data and information points over all the States. While this process allowed us to examine "national" trends, the regional, State and local trends, even though strong in particular places, at times became "smoothed over" or "moderated," perhaps even giving the appearance of being non-existent or having minimal environmental impact.

Because of the national scope of this risk assessment, the team was not able to scrutinize all the data sources that we might like to have done down to the State or local levels. To do so would have required some of the largest computers available to say nothing about the cost. Additionally, at times we had to rely on the best long-term experience and judgments of NRCS personnel including program managers, economists, biologists, resource conservationists, and others with as much as 40 years of individual experience in natural-resource fields. Their judgments, plus the environmental analysis that was done in support of the team's discussions, allowed this report to be developed by examining agriculturally related risk initiators, leading to ecosystem stressors and effects and finally to the risk assessment endpoints.

Overlaying EQIP onto this risk framework allowed the team to visualize precisely how EQIP would "react" as an "enhancer" of environmentally stressed situations. While EQIP is designed to improve environmentally degraded conditions, the team worked with the supposition that in the past agricultural "improvement" programs often corrected one environmental condition only to see another condition get worse. With this in mind, the Risk Assessment Team examined all potential environmental enhancements as "two-edged swords" and recognized that program managers need to consider all aspects of the environment as they constitute the EQIP program.

Program managers must: identify the uncertainties; reduce as many of the adverse risks as possible; and provide for environmental enhancement and benefit. To the end that EQIP program administrators can accomplish this, the program will be a success and there will be conservation and environmental improvements, especially from an ecosystem viewpoint.

4.3 POTENTIALS FOR RISK REDUCTION

Throughout this Risk Assessment, numerous environmental hazards resulting in part or wholly from agriculture, have been identified, localized by production region, and assessed as to potential cause. The discussion has also indicated potential direction and guidance for program managers to utilize when both designing and implementing the overall program. The missing element is an analysis of the amount of potential environmental risk reduction that would occur through appropriate and proper implementation of EQIP. This chapter will attempt to provide an identification of potential risk reductions.

Predictive models have been used through the years to give natural resource and land use planners an indication of the potential for success or failure when a practice or combination of practices are implemented. Various models have been developed for use from very site specific analyses to entire watershed analyses. An example of the usefulness of predictive models is presented here in a simulation of the impact of improved pesticide management practices in a watershed. Map 4.3.a, "Potential Environmental Risk from Pesticides" has been developed to simulate the implementation of improved pesticide management practices over a watershed. The map on the left-hand side clearly indicate where there are risks to the environment using current pesticide management practices, while the map on the right-hand side is a simulation of the effects on pesticide transport when improved management systems are adopted.

Additional predictive models need to be developed using available technology, including geographic information systems, to array data in a spatial form so that problems and potential solutions can be more adequately identified. Models can be use to assist managers with the prediction of risk cause-and-effect, and to more adequately direct financial and technical assistance funds. Models, such as these, could also be used to predict and monitor program effectiveness.

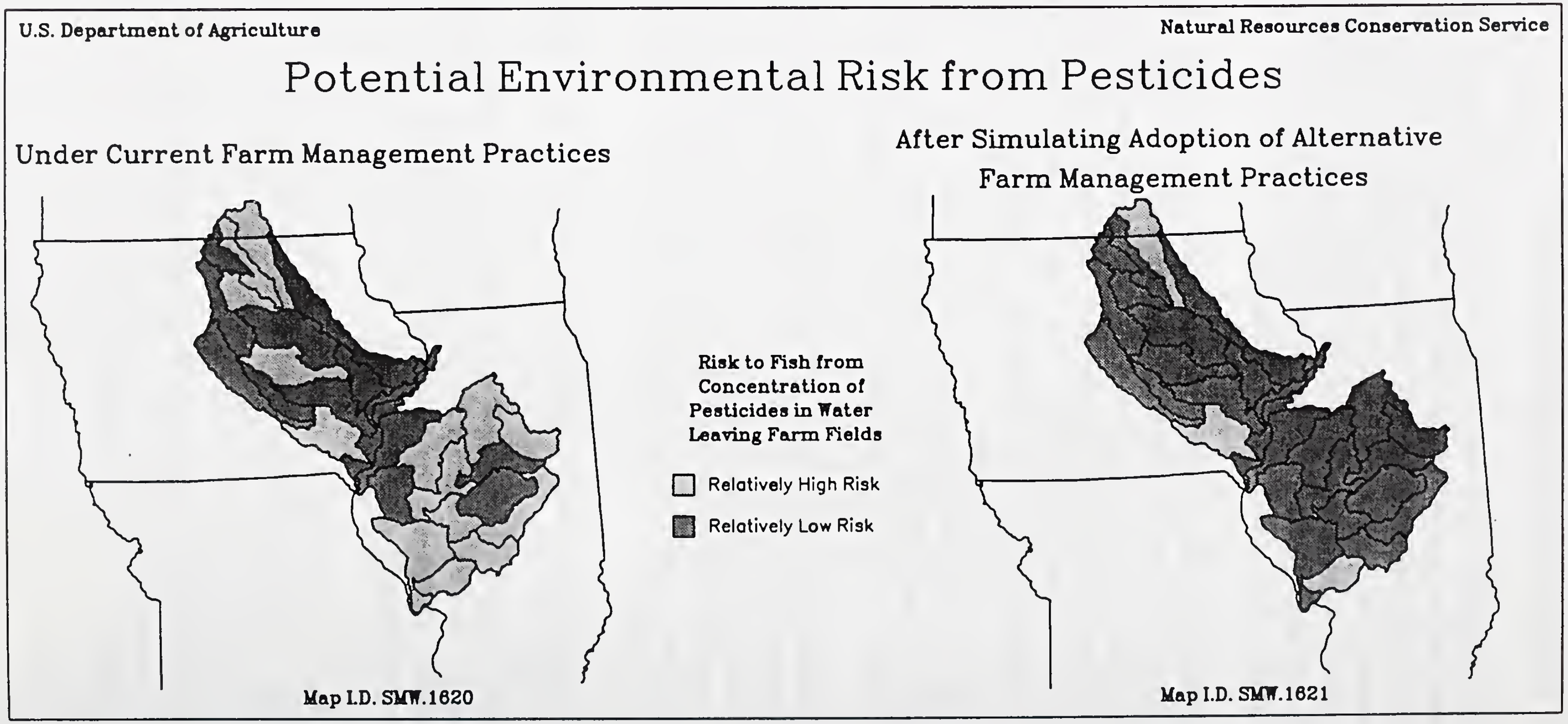
4.4 EQIP BASELINE COMPARISONS AND SUMMARY CONCLUSIONS

The conservation initiatives at the heart of the four previously authorized programs, the Agricultural Conservation Program (ACP), the Water Quality Incentives Program (WQIP), the Great Plains Conservation Program (GPCP), and the Colorado River Salinity Control Program (CRSCP), comprise the basis of the new Environmental Quality Incentives Program (EQIP).

EQIP was authorized by Congress at a funding level of $200 million annually through the year 2002. The four programs, that formed the basis of EQIP, generated the following levels of funding and benefits averaged over the past 7 years:

While the four original programs averaged $260.3 million annually for technical and financial (cost-sharing) assistance, EQIP funding, set at $200 million annually, has the stipulation that one-half of the funds be directed to livestock production related issues. This represents a 23.2

Map 4.3.a



U.S. Department of Agriculture
Natural Resources Conservation Service
Potential Environmental Risk from Pesticides
Under Current Farm Management Practices
After Simulating Adoption of Alternative Farm Management Practices
Risk to Fish from Concentration of Pesticides in Water Leaving Farm Fields
Relatively High Risk
Relatively Low Risk
Map I.D. SMW.1620
Map I.D. SMW.1621

Table 4.4.a Baseline Comparisons

Measurement	ACP	WQIP	GPCP	CRSCP
Tech/Admin Assistance (million $)	11.5	17.3	8.8	3.4
Financial Assistance (million $)	180.4	19.5	13.3	6.1
Erosion Control (%)	62.4		95	5
Water Conservation (%)	13.6			
Water Quality (%)	16.2	100	5	95
Other (%)	7.8			
Erosion Reduction (Tons-million)	33.3	2.0	7.2	0.7
Nitrogen Reduction (Lbs-million)		10.6		
Phosphorus Reduction (Lb.-million)		12.8		
Pesticide Reduction (Lb.-Act. Ingr.)		0.5		
Salt Load Reduction (Tons)				104,000
Deep Percolation Reduction (Ac/Ft)				90,130
Number of Participants	121, 440	177	6,950	280
Acres Served (million)	9.0	5.0	17.3	0.2
Number of Projects	Nationwide	49 States	10 States	4 States

percent decrease in available funding over previous program levels. To ensure Congress's intent of maximizing environmental benefits per dollar expended is met, EQIP actions and activities must be directed to those areas where treatment will provide the greatest protection for the natural resource areas that are most at risk.

The four older programs, while designed to reduce specific threats to the environment, were not necessarily directed to areas that were the most at risk environmentally. The ACP, funded on average at $190 million annually, was distributed where the moneys could effect local conservation efforts, but without regard for overall environmental risks.

The Great Plains and the Colorado River Salinity Programs were targeted to specific regions (High Plains and Colorado River Basin) and for specific purposes (erosion and salinity reduction). These programs proved to be successful, single focus initiatives, but at high proportionate costs. The Water Quality Incentives Program, the youngest (1992) of the four programs, was specifically directed toward practices that would reduce the effects of agricultural pollutants on the Nation's waterways. Initially, the program was targeted to those States with demonstrated national water-quality problems related to agriculture. However, the program came to be applied to targeted Hydrological Unit Areas (HUAs) in 49 States.

A brief analysis of the four programs shows that a "directed solution" to approaching natural-resource problems from agricultural sources would be the most effective. Agriculturally related problem sources are very interconnected with one problem source interlinked with other sources to form proportionately greater synergistic problems than either source acting alone. For example, pesticide molecules from a Minnesota farm can become attached to a soil particle from an Iowa cornfield, be transported down the Mississippi River where other chemicals become

attached to the particle and have an adverse offsite effect in the wetlands of Arkansas or Louisiana.

To have a successful program and to avoid these adverse synergistic effects on large ecosystem scales, EQIP program managers must: determine where natural resources are at risk environmentally; develop priority area plans that will place program dollars for conservation purposes where agricultural practices are adversely affecting environmentally sensitive areas; and place those dollars in problem areas even if the effects being corrected are two counties away or in the next State or region.

If EQIP is to be more effective than the four programs now deauthorized, with less available funding, then the financial, technical, and educational assistance must be focused on areas with the most environmental need, or contributing to the most damaging environmental problems. For EQIP to maximize environmental benefits per dollar expended, the program needs to address those sectors producing the most serious adverse effects on the most environmentally sensitive areas.

4.5 RECOMMENDATIONS TO RISK MANAGERS

A report issued by the General Accounting Office (GAO) indicated that some agricultural conservation programs fell short of achieving their overall erosion protection objectives. The GAO report listed two major problem areas: inadequate attention to the objectives; and lack of priorities to focus upon (Source: 1982 RCA Final Report and Environmental Impact Statement). While these reports may appear dated, they indicate a long-term lack of an overall focus for natural resource protection programs.

Assessments of the past four programs, ACP, WQIP, GPCP, and CRSCP indicate that the financial and technical assistance previously provided was beneficial to farmers and ranchers, and was basically effective in addressing environmental problems. However a more focused approach to natural resource protection is needed to ensure meeting the Congressional mandate that EQIP maximize environmental benefits per dollar expended.

The Council on Environmental Quality (CEQ) regulations require that Federal agencies assess the cumulative effects of proposed actions. (Source: Memorandum, Sept. 26, 1996, Council on Environmental Quality.) The Risk Assessment Team has attempted to analyze where the cumulative effects or impacts of agricultural activities are occurring in the environment. By using thematic maps of different resource or landscape features, resources and areas can be rated as to their risk from degradation. In this manner, a more accurate picture of the types, locations, and extents of agricultural activities and their relationship to environmental resources potentially at risk can be ascertained.

An appropriately conducted cumulative analysis can assist risk managers in assessing where the critical or priority treatment needs for a particular State, Region, or the Nation as a whole are located. An attempt has been made while conducting this Risk Assessment, to perform a

cumulative effects analysis with data currently available. Public Law 104-127 requires annual evaluation and monitoring of the implementation and effectiveness of EQIP. The evaluation needs to be designed to adequately reflect EQIP environmental mitigation efforts. Program implementation strategies can then be adjusted to reflect the results of the new information.

Remote sensing and geographic information system (GIS) technology can provide a means of analysis to record historical changes in the natural resource, ecosystem, or human community condition, as well as relevant stress factors. This type of analysis can give broad, general trends in resource protection levels, associated risks, and needs. Needs-identification at the local level can assist in the overall implementation of EQIP by allowing decision makers more flexibility for providing the most cost-beneficial program implementation options.

A preliminary cumulative effects analysis has been developed utilizing maps showing general resource conditions relating to specific, identified stressors, combined with data from the 1992 NRE, the 1994 EPA 305(b) reports of the States, and other appropriate natural resource data. The analysis has been conducted by the 10 Agricultural Production Regions. These production regions have an ecological basis, as well as a production basis, so in the following analysis and discussion, the production regions serve as surrogates for ecoregions. Discussion and analysis focuses on activities in which assessment endpoints, or natural resources have been placed most at risk, the probable causal agents or stressors responsible (i.e. soil erosion), and the most likely potential for mitigation of the resource problems identified by EQIP, or EQIP in combination with other Federal, State, or local program opportunities.

4.5.1 RISK ASSESSMENT ECOREGIONS

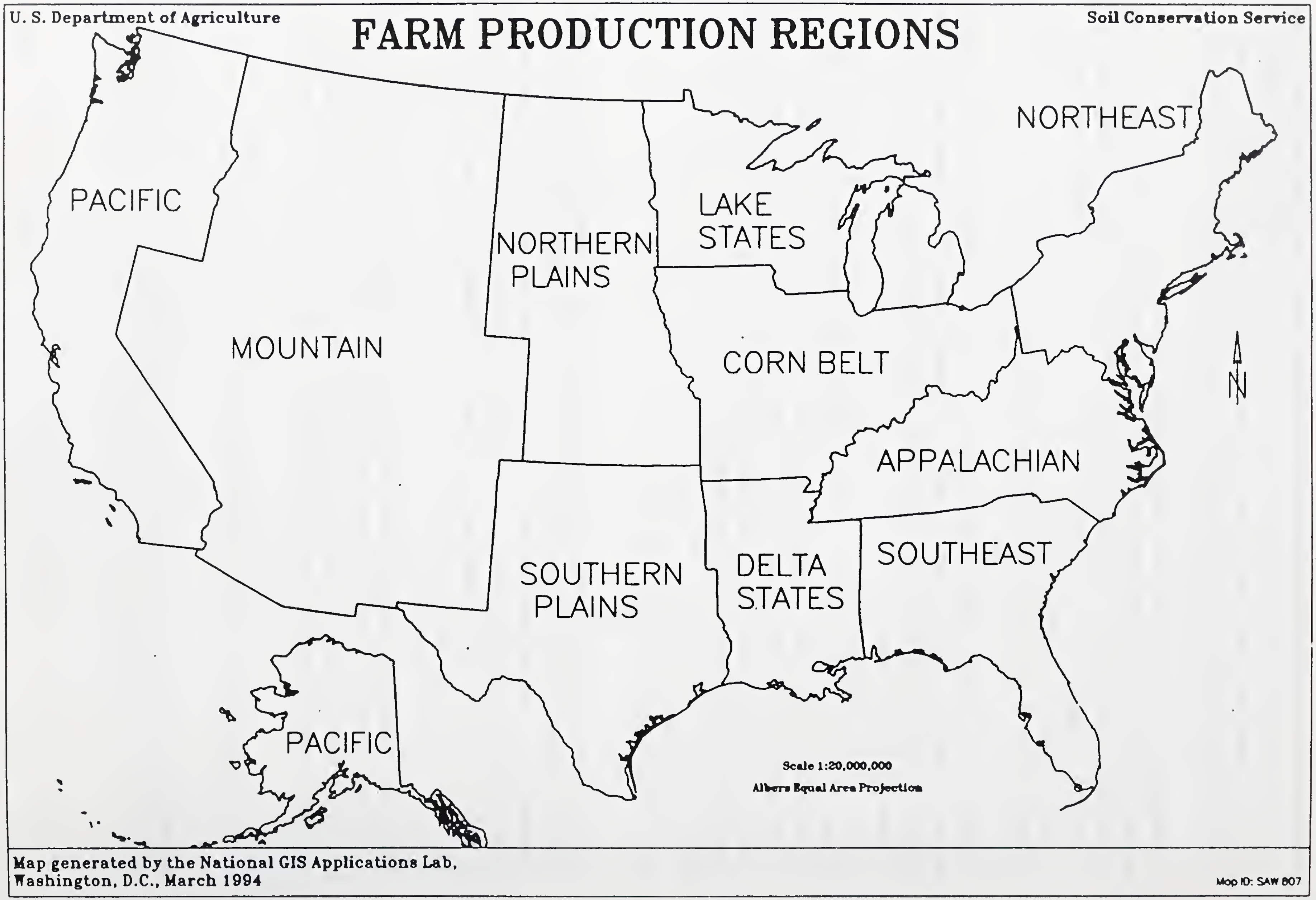
Much of the data analysis contained in this section has been gathered and displayed by "Farm Production Regions" as shown in Map 4.5.1.a. The format of presentation has been done to facilitate making in-depth analyses on the extent and locations of the risks placed on the soil, water, and related resources, including grazing lands, wetland, and forest lands from agricultural activities. Utilization of the ecoregions can also assist EQIP managers at National, State, and local levels to be more aware of an individual State's status with regard to an entire ecosystem.

There are 10 Farm Production Regions across the country. A brief description of each region's State makeup, prevalent natural resources, common agricultural enterprises, general climatic information, and cultural/historical information is followed by the preliminary cumulative analysis with recommendations to the risk managers.

4.5.1.1 NORTHEAST ECOREGION EQIP POTENTIALS

Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland.

Map 4.5.1.a.


U. S. Department of Agriculture
FARM PRODUCTION REGIONS
Soil Conservation Service
PACIFIC
MOUNTAIN
NORTHERN PLAINS
LAKE STATES
NORTHEAST
CORN BELT
APPALACHIAN
SOUTHERN PLAINS
DELTA STATES
SOUTHEAST
PACIFIC
N
Scale 1:20,000,000
Albers Equal Area Projection
Map generated by the National GIS Applications Lab,
Washington, D.C., March 1994
Map ID: SAW 807

This cool-to-temperate, humid region consists of plateaus, plains, mountains, ridges and valleys, and coastal lowlands. Average annual precipitation ranges from 30 to 52 inches. In most of the region, more than half of the precipitation falls during the freeze-free season. Average annual temperature is from 37 to 57 ^{o}F. The freeze-free period is 110 to 200 days, but ranges from 80 days in the mountains to 220 days along the Atlantic Coast.

Much of the land is forested, especially in the steeper areas. Significant amounts of lumber and pulpwood are produced, while locally Christmas trees and maple syrup products are important forest crops. Forage and grains for dairy cattle are principal crops to the north. In places where markets, climates, and soils are favorable, fruits, potatoes and vegetables are important crops.

In the southern portion of this region, farming is highly diversified with truck crops, fruits, and poultry being important sources of income, particularly on the coastal plains. Forage crops, soybeans and grain for dairy and beef cattle are significant. Large-scale corporate farms on the coastal plains are associated with canning and frozen food industries. Many farms are operated by part-time operators who earn much of their living in nearby cities. Rural leisure residences occupy many sites that are less favorable for farming. Urban areas are encroaching on farmland areas. Wildlife and recreation are important land uses in both the northern and southern areas.

The Northeast Ecoregion with its high density of population centers stretches along the northeast corridor from Portland, Maine, to Washington, DC. Its mixture of natural aspects and urban areas create an ever changing landscape along its length. In many places agriculture is mixed with urban and suburban features making a patchwork of land uses. While agricultural patterns predominate the landscape to the south, the northern tier of States is less so.
Stressors having significant cumulative impacts on the environment in the Northeast Ecoregion have been identified as: soil erosion, including suspended sediment, and reduced soil depth; compaction; nutrient losses; odors; pathogens; pesticide and herbicide losses through runoff; and livestock management concerns, including manure and dead animal disposal, and water consumption.

In the Northeast Ecoregion, EQIP has the potential to have a great influence and positive impact on the following Risk Assessment Endpoints:

1. Function of Wetlands and Riparian Areas
2. Viability of Aquatic Communities
3. Survival of Threatened and Endangered Species
4. Extent of Natural Habitats
5. Viability of Terrestrial and Avian Wildlife Communities

Wetlands, aquatic communities, and riparian areas are important features needing protection. In fact, most States in the region have either State or local rules or laws prohibiting the transfer of water from one watershed to another. The region's landscape is covered with many small-scale wetlands and riparian areas, being more abundant in the north and less abundant to the south where larger tracts of land are devoted to agriculture.

Natural habitats are interspersed between agricultural and developed areas, especially in mountainous parts. Generally, these habitats are covered with second-growth forests, having been cut-over many times in the last 300 years. Nevertheless, the habitat is healthy and supports good game species for hunting and fishing. Tourism provides a substantial economic base for local residents, thus maintaining high-quality natural habitats and terrestrial and avian species is a top priority.

With Northeast Ecoregion assets being primarily centered on natural habitats, wetlands, riparian areas, and associated communities, EQIP should concentrate its environmental efforts towards preserving and enhancing these ends, as much for protecting agricultural operations for the operation's sake as for preserving open and green space in a highly congested region.

The EQIP erosion prevention efforts should be directed toward areas of soil loss of twice tolerance (2T) or more, such as parts of upstate New York, much of eastern Pennsylvania and parts of northern New Jersey. The steep slopes of Pennsylvania pose particular anomalies, since the traditions of the area are to keep farming those slopes in spite of the highly erodible nature of the soils.

Generally, nitrogen and phosphate fertilizer runoff and pesticide leaching from farm fields are little problem in the northern parts of the Ecoregion, but in Southeastern Pennsylvania and the Delmarva Peninsula these losses threaten local water supplies, both above and below ground. EQIP should concentrate efforts in these Southern parts to help protect water quality and water supplies for drinking and other uses associated with Chesapeake Bay efforts.

EQIP livestock efforts should be directed toward the preservation and protection of natural resources in the region. In particular, dairy and beef cattle should be kept out of streams by a variety of methods, including fencing where appropriate, providing water tanks away from streams, and providing shade for cattle.

4.5.1.2 APPALACHIAN ECOREGION EQIP POTENTIALS

Virginia, West Virginia, North Carolina, Tennessee, and Kentucky

This borderland ecoregion between the North and the South includes the Appalachian Mountains, ridges and valleys, and dissected plateaus. The average annual precipitation is 40 to 57 inches in much of the region with an average annual temperature between 48 and 68 °F. The freeze-free period is 180 to 200 days in a large part of the region, but ranges from about 140 days in the northeastern part to about 240 days in some of the southern parts.

Small general farms are characteristic of much of the region, but large dairy and livestock farms are located on more favorable soils. Corn, soybeans, small grains, and hay are the chief crops. Tobacco is an important cash crop, especially in the eastern two-thirds of the ecoregion. The

steeply sloping land, which is nearly one-half of the region, is mainly forested and used for both timber production and recreation.

In the gently sloping to rolling southern Piedmont and upper Coastal Plain areas of the region, precipitation is considerably higher in the midsummer than in the rest of the year. Forests are important features in the ecoregion and are the major land use in most areas. Cotton is an important crop in addition to the above-mentioned crops. Pastures are important to this part of the ecoregion with dairying a significant enterprise locally. Livestock is a growing enterprise, especially poultry and hogs.

In the Appalachian Ecoregion with its interspersion of landscapes and uses ranging from coastal recreation to raising crops and livestock, residents are concerned about keeping agriculture a viable enterprise. Generally, the region is rural in character and agricultural interests have predominated in the past, but urban and suburban areas are growing rapidly leading to social conflicts in certain areas.

Stressors having significant cumulative impacts on the ecological resources in the Appalachian Ecoregion have been identified as: soil erosion and compaction; sedimentation, siltation, and shading; nutrient losses from runoff and leaching; pesticide and herbicide losses from leaching; and livestock management concerns, including manure and dead animal disposal, and land disturbances.

In the Appalachian Ecoregion, EQIP has the potential to have a great influence and positive impacts on the following Risk Assessment Endpoints:

1. Structure of Offsite Resources and Habitats
2. Quality of Cultural and Historic Resources
3. Viability of Terrestrial and Avian Wildlife Communities
4. Viability of Aquatic Communities
5. Potable Water Supplies
6. Function of Wetlands and Riparian Areas
7. Quality of Landscape Resources
8. Survival of Threatened and Endangered Species

There is a significant concentration of threatened and endangered species in the central and western parts of the ecoregion. The mountains provide excellent habitats for these species of concern as well as the narrow strip of coastal communities in the eastern part of the region. Where species are threatened by the presence of agricultural activities, EQIP should concentrate its efforts in helping to preserve and protect these species.

The predominance of wetlands are located in the eastern and western portions of the ecoregion as the landscape grades toward the Atlantic Ocean and the Mississippi River.
In these areas, conservation efforts should be directed toward protection of these landscape features, if only because many of the wetland and riparian areas often support threatened or endangered species. Additionally, these areas and many other offsite resources and habitats

contain cultural and historic resources, that are protected by several laws concerning Native Americans and their artifacts.

Average annual soil erosion on cultivated cropland is twice tolerance (2T) over much of the Appalachian Ecoregion, except where the mountains are located and in the coastal plain. Highly erodible lands occupy much of the ecoregion, amounting to as much as 75 percent of the land area. EQIP should continue efforts that have been started to reduce soil erosion in erosion-prone areas and ensure that soil erosion can be brought to levels even lower than at present.

Sheet and rill erosion is present over much of the ecoregion. While reduced tillage has made great strides, conventional tillage still remains a predominant practice for the region's crops. The EQIP should direct even more effort toward slowing erosion in west Tennessee, thus reducing a large component of the sediment delivered to river systems leading to the Mississippi River. It would alleviate the need for much of the maintenance dredging that presently must be done to keep the Mississippi and other rivers open for barge traffic and recreational pursuits.

Nitrogen and phosphate fertilizer losses from farm fields are a significant factor throughout the ecoregion. Losses are heaviest in coastal areas and those areas adjacent to the Mississippi River. These areas pose potentially large ecological threats because of the nature of the highly erosive soils and because water is a medium of rapid transport to other vulnerable sectors.

Pesticide runoff is particularly great adjacent to the Mississippi River, but medium-to-low throughout much of the rest of the ecoregion. However, both eastern and western sectors of the ecoregion are extremely vulnerable to pesticide leaching to lower levels of the water table. Groundwater supplies in this region are especially susceptible to pollutants because of rapid transport through the Karst topography. This is a very serious situation because more than 40 percent of the rural water supply is from groundwater sources. The EQIP should pay great attention to slowing or eliminating both nutrient and pesticide runoff from fields in areas where these compounds have especially quick routes to watercourses and water bodies and to potable water supplies both above and below ground.

Hog and chicken raising has grown in some parts of the region at accelerated rates in recent years and with that rapid growth has come related water and odor problems. With the mandate from Congress to address livestock problems in EQIP, the problems associated with hog and poultry-raising must be directly addressed in the Appalachian Ecoregion, especially to protect potable water supplies, either surface or groundwater.

4.5.1.3 SOUTHEAST ECOREGION EQIP POTENTIALS

South Carolina, Georgia, Alabama, and Florida

This ecoregion consists of gently sloping-to-rolling southern Piedmont and upper Coastal Plain plus the Florida ridge. The average annual precipitation is 40 to 60 inches in much of the region

with precipitation considerably higher in midsummer than in the rest of the year. The average annual temperature is between 61 and 77 ^{o}F in most of the region, but is as low as 57 ^{o}F in some of the higher parts. The freeze-free period is 200 days in a large part of the region, but can be 365 days in Southern Florida.

In the Southeast Ecoregion, forests are important throughout and represent the major land use in many areas. Cotton, soybeans, small grains and corn are the main crops. Tobacco and peanuts are important locally. Pastures are important and in some places are the main land use. Dairying is an important enterprise locally.

Florida's citrus fruits, other subtropical fruits, and winter vegetables are its major crops. However, the acreage in pasture and range is somewhat greater than that in crops. More than two-thirds of the State is in forest of native vegetation, much of which is grazed. Beef cattle are the principal livestock, and dairying is an important enterprise near large cities. In South Florida sugarcane is the principal crop

In the Southeast Ecoregion, with its heavy emphasis on agricultural enterprises in much of the area, livestock and plant yields form the basis for much of the rural income for its residents. Florida's emphasis on citrus and winter vegetables and its large tourism base, places its status in a very different context from its neighboring States. Florida's explosive growth over the last quarter century has caused ecological stress peculiar to the State; however, the expansive growth in general for the region as a result of the energy crises of the 1970s and 1980s, caused changes in the population patterns that are not likely to be reversed. The essentially rural character of the Southeast being predominantly agricultural throughout much of its history, has been changing to one of rapid-growth areas, such as Atlanta and Florida, with expanses of agricultural land intermixed.

Stressors having significant cumulative impacts on the ecological resources in the Southeast Ecoregion have been identified as: Soil erosion, sedimentation and siltation; irrigation water withdrawals, consumption and return flows; nutrient losses from runoff and leaching; pesticide and herbicide losses from aerial applications, runoff and leaching; rangeland brush and weed invasions; and livestock management concerns, including manure and dead animal disposal.

In the Southeast Ecoregion, EQIP has the potential to have a great influence and positive impacts on the following Risk Assessment Endpoints:

1. Viability of Terrestrial and Avian Wildlife Communities
2. Viability of Aquatic Communities
3. Potable Water Supplies
4. Function of Wetlands and Riparian Areas
5. Survival of Threatened and Endangered Species
6. Livestock and Plant Yields

Wetlands constitute a significant part of the ecosystems of the Southeast. For all of the States in the ecoregion bottomland, hardwood wetlands spread over much of the landscape. Much of

Florida's hydrogeology incorporates wetlands along most of the peninsula with extensive waterfowl habitats in much of the State. Wetlands are the predominating factor in the Southeast region. In conjunction with those wetlands and other associated landforms is one of the heaviest concentrations of endangered and threatened species in the Nation. Two factors, wetlands and threatened and endangered species should represent important response items for EQIP. Additionally, aquatic, terrestrial and avian communities will need to be given top priority in the planning endeavors. To be properly responsive to EQIP mandates, agricultural conservation efforts will have to give important weight to these factors in the development and formulation of conservation plans.

Erosion on highly erodible lands was a serious problem in northern sections of the ecoregion in past years but conservation efforts have made significant progress. Soil erosion in the Piedmont is much more moderate and becomes much less of a problem along the coast and in Florida. EQIP should concentrate its erosion control and protection efforts in western portions of South Carolina, and northern Georgia and Alabama, especially where conservation tillage practices can be encouraged and maintained. If in these areas, large acreages are to be released from the Conservation Reserve Program, efforts should concentrate on these lands. Likely, farm economics will be the main determinant of whether expiring acres will be re-entered. Conservation treatments will need to be maintained in the middle portions of these States, particularly where sheet and rill erosion predominate. Probably for much of Florida, only minimal levels of erosion protection will be needed.

Nitrogen and phosphate fertilizer losses from farm fields are an important matter of concern for much of eastern South Carolina, southern Georgia and Alabama. Efforts to control these nutrients should be given significant attention by EQIP because of the proximity to watercourses, water bodies, and major wetland ecosystems that could be adversely affected by heavy inputs of these chemicals. Additionally, the pesticide leaching potentials for the Southeast Ecoregion are extremely high throughout much of the region. The EQIP must pay particular attention to this aspect because certain crops, such as cotton, need large amounts of a number of different pesticides.

The Southeast is one of the fastest growing areas for irrigation, particularly Florida and southern Georgia. Since irrigation water can be a vehicle for rapid transport of pollutants, EQIP must focus attention on irrigation where prevention of the spread of contaminants is the goal, not necessarily the conservation of water as it is in the arid and semi-arid West.

Another rapidly expanding sector of the Southeast Ecoregion is the planting of "pine plantations." This monocultural crop of even-aged species of southern softwoods has been a way of supplying the lumber-hungry needs of a growing society, both in the South and other parts of the country as well. However, the harvesting of large acreages of these trees can create short-term ecologically adverse effects, including water quality and soil erosion problems. While these monocultural environments tend to have low biodiversity values, they do provide some habitat for some species. EQIP should be active in pine plantation areas where the opportunity would exist to increase biodiversity.

Rangeland in Florida is a significant agricultural component on nearly 3.5 million acres of the State. Cattle-raising is extensively conducted on that rangeland, but 40 percent of the rangeland has brush or weed problems, while 37 percent of the rangeland has multiple problems, including brush or weed problems and wind or water erosion problems. With the mandate from Congress to address livestock problems in EQIP, the problems on rangeland must be directly addressed.

4.5.1.4 DELTA STATES ECOREGION EQIP POTENTIALS

Mississippi, Louisiana, and Arkansas

This ecoregion consists of floodplains and low terraces of the Mississippi River south of its confluence with the Ohio River plus valleys and dissected plateaus and the Ozarks. The average annual precipitation ranges from 45 to 65 inches, while the average annual temperature ranges from 57 to 70 ^{o}F. The freeze-free period ranges from 200 to 340 days, increasing in length from north to south.

Most of the soils throughout a large part of the ecoregion are poorly drained. Soybeans, cotton, corn, small grains, and hay are grown throughout the region. Small general farms are a part of the landscape, but large dairy and livestock farms are on more favorable soils. Rice in Arkansas and Louisiana, and sugarcane in Louisiana are important crops locally. The wettest areas, that are not artificially drained, remain in forests that yield important hardwood timber production and wildlife habitats. Many parts of Arkansas are forested.

In the Delta States Ecoregion, agricultural traditions go back many generations on farms that, in many cases, were established in the early part of the Nation's beginnings. Delta region heritages are strong with families having occupied and farmed areas that their grandfathers and great-grandfathers had done before the present generations. Cotton, soybeans, and small grains form the backbone of the region's crops. Tourism is an important industry along the coast of Mississippi and in Arkansas' mountains. Forestry has grown as an important commercial enterprise with the conversion of thousands of acres of land into tree plantations, supplying large quantities of rapidly grown wood to commercial markets.

Stressors having significant cumulative impacts on the ecological resources in the Delta States Ecoregion have been identified as: Soil erosion, sedimentation and siltation; irrigation water consumption, withdrawals, and return flows; and nutrient losses from runoff and leaching.

In the Delta States Ecoregion, EQIP has the potential to have a great influence and positive impacts on the following Risk Assessment Endpoints:

1. Structure of Offsite Resources and Natural Habitats
2. Livestock and Plant Yields
3. Wetlands Function
4. Viability of Aquatic, Terrestrial and Avian Wildlife Communities

5. Survival of Threatened and Endangered Species
6. Good Air Quality

One of the greatest concentrations of wetlands in the Nation occurs in Louisiana. Mississippi, and Arkansas. Wetlands are the single most important factor for the ecoregion in need of protection. The region has one of the highest rates of acres of cropped palustrine wetlands as a percent of cropland and CRP lands, excluding rice production. In most parts along the Mississippi River 4 to 10 or more percent of the cropped lands are palustrine wetlands.

The EQIP can work cooperatively with other wetland-related programs to assure that remaining wetlands are protected from further degradation from agricultural-related activities. The EQIP can also assist with other programs to help restore wetlands where that is a reasonable alternative for the area.

Louisiana, Arkansas, and parts of Mississippi along the Mississippi River constitute a large portion of the Mississippi Flyway. This, in combination with the needs of threatened and endangered species, must be an important consideration for EQIP directions. With bottomland hardwood wetlands and other types of wetlands forming excellent natural habitats for threatened and endangered species, EQIP should work to maintain and enhance the habitats of these species and other species, as appropriate. The entire ecoregion, especially along the coast has significant endangered species populations of these species, some of which could be enhanced by agroecosystems that give equal consideration to the species as well as concern for the livestock and plant yields.

The rapid expansion of "pine plantations" in the Delta States Ecoregion is a circumstance similar to that of the Southeast Ecoregion. Pine plantations, in watersheds draining directly into the Gulf of Mexico, deprive esturarine invertebrates of food, consisting of micro-organisms which live and feed on decaying oak and other hardwood leaves. This has impacted the long-term productivity of esturarine salt marshes in terms of shrimp, oysters, and other related species. Additionally, the monocultural crop of even-aged conifer species may cause short-term and long-term ecological problems. Some of these problems, such as wildlife diversity, can be addressed by EQIP. While they do provide limited habitat for some species, these monocultural environments tend to have low biodiversity values. The EQIP should be active in pine plantation areas where the opportunity exists to improve biodiversity.

Mississippi has a large area of highly erodible cropland from the middle to the southern part of the State to which EQIP should give particular attention, continuing present conservation practices and instituting new conservation efforts where appropriate to address the situational circumstances of these lands. Soil erosion from 1T to 2T and above is mostly concentrated in middle to northern Mississippi with some along the Mississippi River in Louisiana and Arkansas. The EQIP needs to continue supporting conservation efforts, such as conservation tillage, on these erosion-prone areas. The EQIP should continue to utilize new methodologies that will give even better erosion protection to these soils, especially where sheet and rill erosion is predominant.

The EQIP must sponsor vigorous efforts to keep silt and sediment from entering the Mississippi River and its tributaries. The rates of delivery are the highest in the Nation along this stretch of waterway. When considering the clay content of the soils of the area, the chances that these sediment particles may carry attached contaminants is very high. Pesticide leaching potentials and the amount of pesticide entering runoff waters is extremely high for the acreages in proximity to the Mississippi River. This aspect acting in concert with fine clay particles means that the high quantities of silt and sediment delivered to the river systems are probably carrying with them high quantities of attached pesticides. The EQIP must work on both soil erosion and pesticide control simultaneously to reduce the risk to the environment of this combined hazard.

Nitrogen and phosphate fertilizer losses from farm fields follow a pattern similar to that of erosion losses. With a significant area along the Mississippi River devoted to growing rice, irrigation is a necessary part of that agriculture, but this use of water provides a rapid conduit for nutrient compounds. Much of the losses from these agricultural areas drain into the Mississippi River system. Since many of these nutrient losses to the aquatic environment are in soluble form, EQIP needs to address conservation strategies for reducing the entrainment of these compounds into waters adjacent to the farmlands.

4.5.1.5 CORN BELT ECOREGION EQIP POTENTIALS

Ohio, Indiana, Illinois, Iowa, and Missouri

Fertile soils and a favorable climate make this ecoregion one of the most outstanding grain-producing regions of the world. The average annual precipitation is 25 to 35 inches in much of the region, but ranges from 20 inches in the extreme northwest to 45 inches in the southeast. Somewhat more than one half of the precipitation falls during the growing season. The average annual temperature ranges from 43 to 55 ^{o}F. The freeze-free period is 140 to 180 days in most of the region, but it is as short as 130 days along the northern fringe and as long as 235 days in the southwest.

Corn, soybeans, oats, and other feed grains are the chief crops. Hay and winter wheat are important crops locally. Much of the grain is fed to beef cattle and hogs on the farms where it is grown. However, a large amount is shipped to other regions for livestock feed, exported to foreign countries or processed for food and industrial uses.

This largely homogeneous agro-ecoregion known as the "bread basket" of the Nation lives up to its name and more, especially from an agricultural standpoint. Corn and soybeans are the primary crops of the region and literally fuels the entire region. Beef and hogs are the primary recipients of the corn that is grown locally, but a large portion of the crop is available for export to other countries.

The land tends to be level to gently rolling. Much of the soils are loess soils that remained after the settlers drained many of the lands and wetlands to create farms in the 1800s.

Industrialization caused cities to spring up in farmland areas to produce the tools and implements that a growing Nation needed, but farming is still the mainstay for much of the region.

Stressors having significant cumulative impacts on the ecological resources in the Corn Belt Ecoregion have been identified as: soil erosion, sedimentation and siltation; nutrient losses from runoff and leaching; pesticide and herbicide losses from aerial applications, runoff and leaching; odors; pathogens; and livestock management concerns, including manure disposal.

In the Corn Belt Ecoregion, EQIP has the potential to have a great influence and positive impacts on the following Risk Assessment Endpoints:

1. Livestock or Plant Yields
2. Good Air Quality
3. Function of Wetlands and Riparian Areas
4. Survival of Threatened and Endangered Species
5. Potable Water supplies
6. Viability of Avian Wildlife Communities
7. Structure of Offsite Resources and Natural Habitats

In a region where cropping is the norm and wetlands are not as prolific as they once were, biodiversity is diminished.. Much of the region has been converted to agricultural and other purposes, leaving available natural habitats at a premium.

The EQIP should work at enhancing or restoring offsite resources and natural habitats as a way of not only improving conditions for threatened and endangered species, but also toward making natural habitat improvements that could benefit an entire array of species. One way of doing this would be to combine efforts with USDA's Wetlands Reserve and Wetlands Conservation Programs to enhance, restore, preserve, or protect wetlands or riparian areas. Since these areas are often the location of many different species, including threatened and endangered species, biodiversity could be increased more quickly than with other approaches. Additionally, enhancing farmlands to add to the protection of species utilizing the Mississippi Flyway should be a main priority.

New approaches, such as Nutrient-Sediment Control Systems (NSCS) that incorporate a constructed wetland within them, could assist in reducing contaminated runoff from fields and could be adapted to help control animal waste disposal problems. Since most animals fail to distinguish between a natural wetland and a constructed wetland, biodiversity could be increased while agricultural pollution treatment proceeds. Additionally, since USDA developed the technology for NSCS's, implementing the systems should be routine.

Livestock and plant yields are vitally important to agricultural interests of the Corn Belt region A significant part of the corn and grain production support the beef and hog production of the area. However, this leads to air and water quality concerns; where dead animals and manure must be disposed of and where odors can be intense. This is of special concern when urban developments are ;in close proximity to animal production areas. The EQIP should continue the

work of previous programs on these water and air concerns and should concentrate its efforts in areas where the most serious impacts are occurring.

Cropland comprises as much as 75 percent of the land area. Soil loss over significant portions of the Corn Belt are between T and 2T with extensive areas in Missouri and Iowa exceeding twice the tolerable amount (>2T) of soil loss for the area. In most of the Corn Belt, sheet and rill erosion is the predominant form of erosion from cropland providing the highest rate of sediment delivered to river and streams.

The highest losses in the Nation for nitrogen fertilizer (>8.7 lb/ac) and phosphate fertilizer (>1.75 lb/ac) occur over most of the Corn Belt. Additionally, the highest national pesticide leaching index (>300) exists in much of the area. These numbers are a direct result of intensive cropping with its use of fertilizers and pesticides combined with extensive animal-raising efforts and the utilization of animal wastes on agricultural lands.

Conservation activities in the region should concentrate efforts to reduce delivery rates of sediment, nutrients and pesticides to river systems, if environmental risks are to be reduced. Employing conservation measures, such as buffer strips between cropland and waterways, advocating more conservation tillage and working conservation plans in tandem with other agencies' environmental/watershed efforts, will provide positive cumulative impacts on the environment. In this way, water as a conduit for soil, nutrients and pesticides will be eliminated as a vehicle of pollution to other parts of the country through the Mississippi River system.

4.5.1.6 LAKE STATES ECOREGION EQIP POTENTIALS

Michigan, Wisconsin, and Minnesota

In the southern parts of the Lake States Ecoregion, soils and climate are favorable for agriculture. Typically, the land surface is a nearly level to gently sloping glaciated plain. The average annual precipitation ranges from 27 to 36 inches, but is up to 45 inches in the extreme eastern part. Precipitation is fairly evenly distributed throughout the year. In most of the ecoregion, the average annual temperature is 43 to 52 °F. The freeze-free season generally is 130 to 180 days, but is as long as 200 days in narrow belts adjacent to the Great Lakes. The region has a wide variety of agricultural enterprises. Dairy farming is important. Canning crops, corn, soft winter wheat, beans, and sugar beets are among the leading crops. Fruits, especially sour cherries, are important in the narrow belts adjacent to the Great Lakes. Much of the cropland near the larger cities is being subdivided and developed for urban uses.

In the northern parts of the ecoregion, soils are poorly suited to cultivation and a short cool growing season severely limits agriculture. The average annual precipitation is 20 to 32 inches with maximum rainfall during the growing season. The average annual temperature is 36 to 45 °F with a freeze-free period ranging from 95 to 145 days. A large part of the ecoregion is forested with lumbering and recreation the principal uses. Mining is a major industry in all parts

of the region, except the east. Forage and some grains are grown for dairy cattle and other livestock. Locally, potatoes and vegetables for canning are important crops.

In the Lake States, the quality of life and the environment are important concerns. While the southern parts of the region are primarily agriculturally oriented, and are often considered to be part of the Corn Belt, northern parts are not oriented toward agriculture, but residents make their living from the natural resources of the land itself or from tourism linked to those resources.

Stressors having significant cumulative impacts on the ecological resources in the Lake States Ecoregion have been identified as: soil erosion, sedimentation and siltation; nutrient losses from runoff and leaching; and pesticide and herbicide losses from aerial applications, runoff and leaching.

In the Lake States Ecoregion, EQIP has the potential to have a great influence and positive impacts on the following Risk Assessment Endpoints:

1. Structure of Offsite Resources and Natural Habitats
2. Function of Wetlands and Riparian Areas
3. Viability of Aquatic Communities
4. Survival of Threatened and Endangered Species
5. Viability of Avian Wildlife Communities
6. Quality of Landscape Resources

The key to implementing EQIP in the Lake States Ecoregion is recognizing that offsite resources and natural habitats are the ecological drivers of the entire region. While the area does not have an inordinately large number of threatened and endangered species, the three States, located at the "top" of the Mississippi Flyway, host an extraordinary number of birds and a great diversity of avian species, which rely on the ecoregion's many and varied wetlands.

In the southern parts of the region, controversy has existed for some years surrounding the wetlands and their potential role in agricultural production. As EQIP is employed, it must be sensitive to the needs of the farmers of the region, while at the same time recognizing the needs of the natural resources that characterize the region. For example, southern Michigan, Wisconsin, and Minnesota have some of the highest percentages (4 to 10 percent or more) in the Nation of acres of cropped palustrine wetlands and CRP lands, excluding rice.

Except for a small corner of southwest Michigan and northwest Minnesota, highly erodible land in cropland is not a major concern. With the exception of the northwest corner of Minnesota much, of the rest of the agricultural lands to the south have moderate rates of soil erosion from cultivated cropland (T to 2T). Sheet and rill erosion contribute a significant amount to the total erosion, providing moderate-to-high amounts of sediment delivered to rivers and streams at the headwaters of the Mississippi River.

Nutrient losses of nitrogen and phosphate fertilizers are a serious problem in the southern agricultural region with losses ranging from medium to high for the area. When these

compounds come into contact with some of the soil particles, the compounds can attach to the particles and be carried much further than would otherwise occur. This method of transport spreads agriculturally related pollution to areas that normally would not experience pollution episodes, creating problems far from the originating source.

The pesticide leaching index and pesticide runoff values are equally high for the southern agricultural area. Pesticide molecules, like nutrients, can attach to soil particles and be carried long distances.

The EQIP should focus conservation efforts in the erosion-prone areas of the Lake States Ecoregion and should continue to advocate conservation tillage efforts wherever possible. Primary objectives should be to keep sediment and attached compounds from reaching watercourses and water bodies to protect water quality and depleted wildlife species.

The EQIP should concentrate its efforts in the Lake States Ecoregion to protecting, preserving, and enhancing offsite resources and natural habitats, including landscape resources. EQIP should operate its program in the Lake States Ecoregion with the thought in mind that the environmental benefits to be gained by implementing practices and procedures in one county may only be observed in the environments of an adjacent county or across a State line. This is especially true where the Mississippi Flyway is concerned. With all of Minnesota, Wisconsin, and Michigan being primary breeding locations for so many species, EQIP will have to take that into consideration as conservation plans are developed for priority areas.

4.5.1.7 SOUTHERN PLAINS ECOREGION EQIP POTENTIALS

Texas and Oklahoma

This region consists of the prairies and savannas in eastern Texas and south-central Oklahoma to the southwest plateaus and southern high plains. It is more temperate to warmer than portions of the northern and western Great Plains. Precipitation ranges from moderately low and erratic to moderate. The average annual precipitation is 14.7 to 45.3 inches throughout most of the region, with ranges from 15 to 35 inches. Generally, much of the precipitation falls in the Spring and in Autumn, fluctuating widely from year to year in the high plains. Snowfall ranges from 4 to 10 inches from south to north. The average temperature ranges from 55 to 72 degrees. The freeze-free period ranges from 130 to more than 325 days, increasing in length from north to south. Freeze-free years are common in the extreme southern part of the region.

Agricultural enterprises range from large acreages devoted to beef cattle grazing to intensively farmed and irrigated cropland, primarily cotton, winter wheat, and grain sorghum. Some areas, especially along the lower Rio Grande Valley, have been devoted to specialty crops and vegetables. Urban expansion has, in the past, placed pressures on the local farms and ranches, especially during the oil boom, but has moderated somewhat.

The elevation and topography increases gradually from east to west, with dissected plains and divides that are undulating to gently rolling. Flood plains are wide and level and less dissected in the eastern portion of the region. Valleys are narrow to broad, with gently sloping to steep walls and smooth undulating floors. The hill region is sloping to very steep. Plateaus are broad and nearly level to undulating.

In the Southern Plains Ecoregion, agricultural emphasis centers on production and yield with both Oklahoma and Texas represented in the top 5 livestock and grain production States in the Nation. Extraction of gas and oil reserves, as well as urbanization in the eastern portion of the region competes intensively for prime land areas and well as for existing groundwater reserves. The high plains aquifers underlying the region are experiencing depletion threats from all usage sources. Tourism involving natural and historic sites also contributes to the stresses placed on the ecosystems of the region.

Stressors having significant cumulative impacts on the ecological resources in the Southern Plains Ecoregion have been identified as: soil erosion, air particulates, sedimentation and siltation; irrigation water withdrawals, consumption, and return flows; salinity; deep percolation; nutrient losses from runoff and leaching; pesticide and herbicide losses from aerial applications, runoff and leaching; rangeland brush and weed invasions; and livestock management concerns, including manure disposal.

In the Southern Plains Ecoregion, EQIP has the potential to have a great influence for positive impacts on the following resources currently at risk:

1. Good Air Quality
2. Livestock and Plant Yields
3. Viability of Avian Wildlife Communities
4. Survival of Threatened and Endangered Species
5. Potable Water Supplies
6. Structure of Offsite Resources and Habitats
7. Quality of Cultural and Historic Resources
8. Function of Riparian Areas

Wetlands and riparian areas represent important ecological components in the eastern portion of the Southern Plains region, particularly the East Texas coastal areas. The diversity of vegetation, terrain, land usage, and relative proximity to the Gulf Coast represents an area diverse in avian and terrestrial wildlife species, many of which are considered as threatened or endangered. A major flyway, the Mississippi Central Flyway, passes directly over this area of the region. The EQIP consideration will need to be given to ranking offerings, and to developing conservation contracts for the preservation, improvement, restoration or enhancement of these environmentally sensitive areas. Major benefits can be achieved in reducing the amounts and kinds of on- and offsite sources of damage to these areas.

Cultivated cropland contributes a disproportionate share of damages within the ecoregion, both from the effects of wind and water erosion. Currently, 53 percent of the cropland in the Southern

Plains region is considered to be highly erodible. Significant reductions in erosion rates have occurred over the past 10 years, but improvements can still be made, especially in the western portions of Texas and Oklahoma, which are subject to high wind erosion events. The EQIP funds can be directed to these areas for reductions in the risks associated with crop production on these environmentally sensitive areas. Greater incentives for usage of conservation tillage and like techniques should be made a part of any EQIP initiatives is this ecoregion to assist in risk reduction.

Currently, 38 percent of the impairments to streams and 64 percent of the impairments to water bodies can be attributed directly to agricultural sources, including pesticides, nutrients and pathogens. Environmental risks can be reduced through the proper use and application of these materials through EQIP-developed plans and monitoring. Water-quality impairments can be significantly reduced, enhancing both avian and terrestrial wildlife habitats.

Salinity, especially along the Rio Grande River, is a problem, whether induced or enhanced through irrigation. Improved irrigation techniques and management and delivery systems can reduce the risks to domestic vegetation and livestock, as well as to regions, which have threatened and endangered species, and avian and terrestrial wildlife habitats. While the Colorado River salinity treaty with Mexico specifically provides for reductions in salt loading to the Colorado River and its tributaries, EQIP has the ability to ameliorate salt and salinity-related damages due to irrigation in other watershed areas as well. The irrigated areas of west and south Texas should be specifically targeted for EQIP salinity reduction funding.

Water depletions, either through irrigation or other sources, are of great concern, especially where threatened and endangered species are prevalent. Irrigation water management improvements can provide agricultural producers with better and more efficient means of water usage, thereby reducing threats from depletions to the species from agricultural sources. The EQIP funds should concentrate on the improvement of both the quantity and quality of water in this sector.

Livestock represents a major contribution of pollutants in both Texas and Oklahoma because of numerous feedlots and confined feeding operations. While the sheer magnitude of size may prohibit total solutions, significant reductions in environmental effects associated with manure management and livestock grazing can be made, if EQIP funds would be directed to those areas that can benefit the most. The major livestock production areas in this region, located in the central to eastern portions, should be targeted for improved livestock grazing and management techniques, as well as more environmentally friendly manure handling techniques.

4.5.1.8 NORTHERN PLAINS ECOREGION EQIP POTENTIALS

North Dakota, South Dakota, Nebraska, and Kansas

This region of the Great Plains consists of rolling uplands, gently sloping ridgetops, steep slopes bordering drainage areas, and nearly level areas. The average annual temperature range from 44 to 64, increasing from north to south. The freeze-free period ranges from 100 days in the north to 240 days in the south. Precipitation ranges from 10.8 inches in the north to 35.4 inches in the south. There is more rainfall in the summer months than during any other season.

Agriculture in the region is varied, from rangelands in the north and western portions, to cash grain farming in southern and eastern portions. Cash crops consist mainly of wheat, both dryland and irrigated; corn and alfalfa. Potatoes, vegetables, and beets are of local importance in some portions of the region. Alfalfa is grown extensively. Specialty crops, consisting of sunflower, safflower, rape seed, and canola are grown on the western plains of Nebraska and Kansas.

Rangeland predominates in the northern and western portions of the region. Irrigation is a major factor for agricultural production in the region, as much of the wheat produced is irrigated.

This is a major livestock production region of the Nation, with both beef cattle feedlots, and confined hog operations. The livestock industry contributes to a sizable portion of the region's income. The turkey industry is prevalent in the southern portion of this region, particularly in Nebraska.

The Northern Plains Ecoregion economy is dominated by crop and livestock production since the first white settlers came to the area in the mid-1800's. While there are a few major commercial centers in the region, primarily Kansas City and Omaha, the land resources have not been exposed to urban pressures, commercialization, and competition that other regions have. The region is relatively sparsely populated, often with many miles between towns of significant size.

Stressors having significant cumulative impacts on the ecological resources in the Northern Plains Ecoregion have been identified as: soil erosion, air particulates, sedimentation and siltation; irrigation water withdrawals, consumption, and return flows; salinity; deep percolation; nutrient losses from runoff and leaching; pesticide and herbicide losses from aerial applications, runoff and leaching; rangeland brush and weed invasions; and livestock management concerns, including manure disposal.

In the Northern Plains Ecoregion, EQIP has the potential to aid in the protection, restoration, and preservation of the following natural resources identified as being placed at risk by agricultural activities:

1. Good Air Quality
2. Potable Water Supplies

3. Viability of Terrestrial and Avian Wildlife Communities
4. Survival of Threatened and Endangered Species
5. Livestock and Plant Yields
6. Function of Riparian Areas and Wetlands

Wetlands, while representing less than 10 percent of the total land mass are particularly important environmental systems in the ecoregion. More than 24 percent of wetlands have been or are currently in crop production. This has contributed significantly to a decline in total wetlands, as well as reducing important habitats for both avian and terrestrial wildlife species. Many threatened and endangered species also make their homes in these areas.

The prairie pothole wetlands in the northern portion of the region are important natural features needing protection, restoration, and enhancement. Additionally, the riparian areas in the region have been degraded through inappropriate livestock grazing. The EQIP can be used to reduce environmental risk to these wetland areas by coordinating and concentrating efforts toward improved management techniques and through enhancement and restoration of the wetlands.

Cropland represents a significant land use throughout the entire four-State region with the production of winter wheat and small grains predominating over the region, and with corn and soybeans in Nebraska and Kansas. All four of these States are subject to the effects of wind and water erosion. Agriculturally related sediment delivery both on- and offsite contribute to degraded water quality, but particularly in eastern Kansas and Nebraska. Agriculture accounts for approximately 10 percent of the impairments to water in the region. In addition to risks from erosion and sediment, a significant risk is caused by the usage of pesticides and fertilizers. Nitrogen and phosphate fertilizer losses from crop fields are an important matter of concern for much of the eastern tier in the region. Efforts to control nutrients should be given significant attention by EQIP because of proximity to watercourses and water bodies and because of the importance of these areas to avian and terrestrial wildlife communities.

Pesticide leaching potentials and pesticides entering runoff waters are extremely high in a large portion of the region, but especially in Kansas and Nebraska and in eastern portions of North and South Dakota. This presents a serious threat to surface- and groundwaters and to ecologically sensitive wetland areas. Corrective actions, combined with activities directed at a reduction in soil erosion, would constitute the most effective reduction in identified risks to the environment for the area.

Air quality is significantly affected by cropland soil erosion in the form of wind erosion. Increased adoption of residue management techniques, as well as better forms of conservation tillage systems need to be introduced and utilized within the region.

Irrigation and irrigation water management is a special concern in this region, both from the standpoint of water quantity as well as water quality. Ground- and surface-water depletions, as well as problems with salt loadings and deep percolation present particular risks to the environment, including wildlife species and in particular, threatened and endangered species.

The EQIP funding and technical assistance should be directed toward reducing the risks to the environment associated with irrigation.

The Northern Plains Ecoregion has a long history of livestock raising, particularly as a region and at one time as a national leader in livestock operations. The stockyards of Omaha and Kansas City are well-know throughout the history of these States. Problems associated with livestock production include significant impacts on air quality and potable water supplies. EQIP can reduce some of the environmental risks by providing improved waste management techniques as well as improved grazing systems in conservation plans.

4.5.1.9 MOUNTAIN ECOREGION EQIP POTENTIALS

Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico.

This region is accentuated by the rugged mountains, which are its dominant terrain feature, along with broad valleys and remnants of high plateaus gradually decreasing to a smooth topography. The short growing season severely limits the crops that can be grown. Average annual precipitation ranges from 9.8 inches to 40.4 inches. It can be less than 9 inches in some valleys to more than 50.2 inches on some mountain peaks. A large part of the precipitation falls during the growing season. Average annual temperatures range from 39.2 to 48.2 over most of the region. The freeze-free period is from 100 to 155 days, increasing from north to south. The freeze-free period in the foothills in the southern part is as long as 160 days. In some of the higher elevations, the mountains are covered by glaciers, and the ground is permanently frozen.

The major crops are winter and spring wheat, both irrigated and dryland. Potatoes, sugar beets, specialty vegetables, flax, and hay, are grown under irrigation along the Snake River. Soybeans and corn are important crops in the Red River Valley. Cotton and citrus fruits are important crops in the southwest. Grain and forage for livestock is also important. Much of the region is utilized for range, with grazing as the leading use of land in the valleys and in the mountains. Lumbering is important in some of the forested mountain areas. A large percentage of this region is public land, devoted to uses overseen by the Federal and State governments. Use of the land for recreation is also important, outstripping agriculture in economic generators, but creating environmental impacts of its own.

Livestock operations, especially ranches, and to some extent on the eastern plains, beef cattle feedlot operations, are traditional agricultural enterprises.

The Mountain Ecoregion, composed of the Rocky Mountain States, has a heavy emphasis on both crop and livestock production. Agriculture represents a major economic contribution to the region, closely followed by recreation and tourism. For the most part, population is sparse with major commercial and industrial centers located in and around Denver, Colorado.

Since the mid to late 1980s, the region, especially the area within 200 miles of Denver along the front range of the Rockies, has experienced explosive urban growth. There is major competition for land usage in this area with areas suited to urbanization undergoing rapid conversion from rural usage. This puts agriculture at odds with suburban and urban communities because of the offsite visual and olfactory effects associated with certain aspects of agricultural production.

Stressors having significant cumulative impacts on the ecological resources in the Mountain Plains Ecoregion have been identified as: soil erosion, air particulates; Irrigation water withdrawals, consumption, and return flows; salinity; deep percolation; groundwater overdrafting; rangeland brush and weed invasions; uncontrolled animal disturbances; and livestock management concerns, including manure disposal.

In the Mountain Ecoregion, EQIP has the potential to provide benefits to following natural resources identified as being placed at risk:

1. Good Air Quality
2. Potable Water Supplies
3. Viability of Terrestrial and Avian Wildlife Communities
4. Survival of Threatened and Endangered Species
5. Quality of Cultural and Historic Resources
6. Livestock and Plant Yields
7. Function of Riparian Areas

Livestock grazing in inappropriate wetland and riparian areas places these environmentally sensitive and important areas at risk, by altering the capacity and shape of natural channels and the ability to carry water efficiently, effectively, and in a non-erosive manner. Dual usage of channels, and the surrounding riparian areas, for both irrigation, and livestock water and loafing areas makes for an environmental anomaly that is impossible to maintain. Both quantity and quality of water and vegetation suffer. Low rainfall and moisture availability, the inherent nature of the rangeland grass species, and over-usage as a whole contributes to increased vulnerability from wind erosion. Disaster due to flash flooding from destroyed or severely altered stream channels can lower both plant and livestock yields, and disturb or destroy wetland and riparian areas.

Livestock enterprises, especially large confinement and feedlot operations, are under extreme pressure to conform to current environmental policies from the largely non-agricultural community. Improvements are needed in both grazing and manure management techniques being used by producers in the region. Agricultural enterprises are being forced to land areas less suitable for crop and livestock production. These lands are less suitable due to being highly erodible, with a low water availability. The EQIP, by providing for better grazing management plans, keeping cattle out of sensitive areas, along with more efficient uses of scarce water supplies can assist in reducing the risks to environmentally sensitive riparian and wetland areas.

Because of the extremely rapid growth experienced in parts of the region, land prices have been driven up, with farms and ranches being subdivided at unprecedented rates. Infrastructure has

been outstripped by this fast-paced development. Naturalists and environmentally aware citizens predominate, and normal agricultural practices, including timber harvesting, are being criticized as being environmentally unsound.

Of greater concern in this region is the availability, or lack thereof, of substantive water supplies. Water is valued more than gold and silver, which is also abundant in the mountainous areas of the region. Low rainfall, coupled with substantial snow pack in the mountains has led to often innovative and unusual methods of water transport and conveyance. Transmountain diversions are not unusual for this region. Water rights dictate the types and amounts of agricultural enterprises in much of the region. Irrigation, both for agricultural production and urban and suburban uses has resulted in adverse affects due to salinity. Ground- and surface-water depletions are a serious issue in the region. Additionally, the salinity treaty with Mexico mandates a reduction in salt loadings in the Colorado River Basin entering that country.

While dramatic reductions in salt loadings and deep percolation have already been achieved over the past 10 years, additional reductions can be achieved. Salinity, however, is not a problem relegated solely to the Colorado basin. The EQIP funds should be directed to the identification of major salt sources in the region and assistance with irrigation management techniques to reduce the adverse affects.

Over the past 10 years, cropland soil erosion has been reduced significantly, but further improvements are still needed if risks to the environment are to be reduced. Significant wind events have produced dust storms that in some cases can rival those that occurred during the dust-bowl period. Air quality standards have been in effect in a majority of the communities on the high plains areas, but additional technology still needs to be developed and implemented to effectively reduce the risk to air quality from agricultural sources.

The EQIP should be directed to those areas shown to be the most at risk due to effects from wind erosion, by providing incentives to convert cropland to less intensive agricultural uses. An additional source of risk may occur when a large majority of the CRP contracts expire in October 1997. A large portion of this acreage devoted to grass for the past 10 years, could potentially go back into crop production, depending upon the agricultural economy. This would be detrimental to air quality and to both avian and terrestrial wildlife habitats. EQIP funds should be directed to converting those acreages permanently to grass or trees.

4.5.1.10 PACIFIC ECOREGION EQIP POTENTIALS

California, Washington, Oregon, Alaska, and Hawaii

This region, except for Alaska and Hawaii, ranges from steep mountains and narrow to broad, gently sloping valleys and dissected plains in the northwest to semidesert to desert areas of plateaus, plains, basins, and isolated mountain ranges to the south and east. The central portion of the region is represented by areas of low mountains and broad valleys. The average annual

precipitation ranges from less than 9.8 inches in most of the plains and basins to more than 85.6 inches in some of the higher mountains. Overall precipitation averages 18.2 to 50.2 inches annually. The northwestern portion of the region experiences dry summers, to arid conditions in the south, with most of the precipitation occurring during the warm season. The central portion of the region experiences a long, warm growing season, with low precipitation. In the southeast, most of the precipitation falls during the cool season.

In most of this region, the average annual temperature ranges from 42.4 to 57.2, with highs ranging into the 70s in the arid, desert areas, to lows of 32 or lower in the mountainous areas. The freeze-free period ranges from 90 to more than 300 days, with a regional average being 136.6 to 246.6 days.

Major agricultural enterprises include extensive crop production in the north, consisting mainly of wheat, oats, and peas under dryland conditions. Fruits, mainly apples, are also a major commodity. In the irrigated, arid and semi-arid areas, feed crops for livestock are grown. Peas, beans, and sugar beets are also grown in many places. Grazing is a major land use, especially in the drier, western portions of the region. The mountains are heavily forested, and lumbering is a major industry. Dairy farming is also an important regional activity in the northwestern valleys, where rainfall is abundant.

The central valley of California produces a wide variety of crops and has a wide variety of agricultural enterprises. Citrus fruits, other subtropical and tropical fruits, and nuts are major crops in the south. Many kinds of fruits and vegetables are grown under irrigation throughout this area. Rice, sugar beets, cotton, grains, and hay are also extensively produced in this area. Dairying is a major enterprise near the larger cities, while beef cattle production on feedlots and rangeland is also important to this portion of the Pacific Ecoregion.

The agriculturally important areas of the Pacific Ecoregion are the Palouse area of Washington, Oregon and Idaho, Oregon's Willamette Valley, Washington's Yakima and Wenatche Valleys and California's Central Valley area. The Palouse area, known mainly for the intensive production of wheat, feed grains, and oats, is a highly sensitive environmental resource area due to the loessial soils of the region. The Willamette, Yakima, and Wenatche valleys primarily support the fruit and vegetable industries. California's Central Valley, on the other hand, is for the most part almost entirely created and maintained through irrigation and water management techniques. The intensity of production is matched only by the extreme diversity of agricultural products grown in the area.

Agriculture provides substantial support for the metropolitan areas in these Western States, especially in California. Competition for land usage is severe over all of California and increasingly so in its neighbors to the North. Rapid growth and urbanization have been commonplace for many years.

Stressors having significant cumulative impacts on the ecological resources in the Pacific Ecoregion have been identified as: soil erosion, air particulates, sedimentation and siltation:

irrigation water withdrawals, consumption, and return flows; salinity; deep percolation; and livestock concerns, including brush and noxious weed control.

The EQIP has the potential to support and improve the following natural resources identified as being at risk in the Pacific Ecoregion:

1. Structure of Offsite Resources and Habitats
2. Potable Water Supplies
3. Viability of Aquatic Communities
4. Survival of Threatened and Endangered Species
5. Livestock and Plant Yields
6. Function of Riparian Areas and Wetlands
7. Quality of Cultural and Historic Resources
8. Diversity of the Avian Wildlife Community
9. Good Air Quality

Three major areas within this region bear the majority of the environmental risks occurring. These areas are the Palouse area of Washington, Oregon, and Idaho; the Puget Sound and coastal area of Washington and Oregon; and the Central Valley area of California. All three of these areas are subject to extensive and intensive cropland cultivation; the northern areas in dryland wheat, primarily, and the irrigated Central Valley in diversified crops as well as specialty crops.

Soil erosion is significant in all three areas, producing adverse effects to wetland and riparian areas, and impairments to water bodies, including lakes and streams. Soil erosion still exceeds 2T in many places within the Palouse area, with sediment delivery to the rivers and streams producing significant effects upon threatened and endangered species along the West Coast. Pesticides and nutrients represent additional risks to the environmentally sensitive areas. The EQIP funding should be directed to improving cropping system management, and pesticide and nutrient management to reduce the risk to the environment.

In some parts of the Central Valley, salinity problems continue to affect crop productivity and habitats that could be used by many species, including threatened and endangered species and species that use the Pacific Flyway. The EQIP could be employed to ameliorate or remedy some of these situations, leading to an improved environment and productivity for the area..

Of additional concern in this region is the availability of a reliable water supply of sufficient quality. Low rainfall, coupled with substantial snow pack in the mountains has led to often innovative and unusual methods of water transport and conveyance. Transmountain diversions are not unusual for this region. Ground- and surface-water depletions are a serious issue in the region, and groundwater overdrafting is becoming more and more serious.

Air quality has been of great concern in the region, mainly from industrial and urban sources, but agriculture contributes a share of the pollutants. Airborne soil particulates, as well as chemical particulates contribute to a worsening air quality problem in the region, especially in California.

Livestock grazing, both on rangeland areas and pasturelands is also a concern with regard to brush and noxious weed control. Desirable species have been displaced, affecting both the viability of raising domestic livestock, and the availability of diverse wildlife habitats.

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APPENDIX A - FINDING OF NO SIGNIFICANT IMPACT

Federal Agriculture Improvement and Reform Act of 1996

Finding of No Significant Impact

for the

Environmental Quality Incentives Program

October 24, 1996

Environmental Quality Incentive Program

The Natural Resources Conservation Service (NRCS) developed this Finding of No Significant Impact (FONSI) in compliance with the National Environmental Policy Act (NEPA) of 1969, as amended. NRCS has completed a series of Environmental Assessments (EAs) to begin implementation of the Environmental Quality Incentives Program (EQIP) provision of the Federal Agricultural Improvement and Reform Act (FAIRA), the 1996 Farm Bill.

Document Purpose

In accordance with NEPA, this document announces the Finding of No Significant Impact for the U.S. Department of Agriculture's (USDA) Environmental Quality Incentives Program, a provision of FAIRA. USDA has concluded that implementing this program will not have significant adverse effects on the human environment, when the program is implemented in an approach that considers both short- and long-term effects to the environment.

This document displays the basic elements and foundations which led to USDA's decision of no significant impact. The document displays the evidence and basic conclusions that led USDA to this finding. The 1996 EA and this FONSI are available from:

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The publication of this FONSI initiates a 30-day review period during which time interested parties can respond to NRCS' proposed implementation of this program by writing, calling, or sending an e-mail response to the person listed above. At the end of the 30-day period, NRCS will assess any comments received and determine if those comments warrant changes in the proposed program.

Background

An EA has been conducted in accordance with NEPA and the implementing regulations of NRCS, 7 CFR Part 650. NRCS acted as the lead agency for this assessment, but the information is based on issues developed by interagency teams.

The Environmental Quality Incentives Program is a new conservation program, reflecting the functions of four previous conservation programs, namely the Agricultural Conservation

Program (ACP), the Great Plains Conservation Program (GPCP), the Water Quality Incentives Program (WQIP), and the Colorado River Salinity Control Program (CRSCP). As of April 4, 1996, those programs were repealed, except that an interim program has been instituted between April 4 and the present time to maintain a basic program until a new program can begin.

The Environmental Quality Incentives Program provides in a single, voluntary program flexible technical, financial, and educational assistance to farmers and ranchers who face serious threats to soil, water, and related natural resources on agricultural and other lands, including grazing lands, wetlands, forest lands, and wildlife habitats.

An overall objective of EQIP is to maximize environmental benefits per dollar spent. Assistance will be provided to help producers comply with Title XII of FSA of 1985, as amended, and Federal and State environmental laws. Also, assistance will encourage environmental enhancement. Producers will be aided in making beneficial, cost-effective changes needed to conserve and improve soil, water, and related natural resources on their farm and ranch operations.

A consolidated and simplified conservation planning process will be used to reduce administrative burdens on producers. To receive EQIP benefits, the law requires producers to submit a plan containing appropriate conservation measures and which becomes the basis for long-term, five-to-10- year contracts with USDA. Funds of the Commodity Credit Corporation will be used to fund the assistance provided under EQIP. For fiscal year 1996, $130 million was made available to administer an interim program; $200 million is to be made available for each of fiscal years 1997 through 2002. Fifty percent of the funding available for the program will be targeted at practices relating to livestock production.

Federal cost-share payments under EQIP shall not exceed 75 percent of the projected cost of a structured practice. Incentive payments will be available to participants for land management practices in an amount and at a rate necessary to encourage a producer to establish the practice he or she would otherwise not perform without financial assistance. Operators of large, confined livestock operations are not eligible for cost-sharing for the construction of structural animal-waste facilities, but are eligible for technical assistance and financial assistance for other conservation practices. Generally, the total amount of cost-share and incentive payments to a person under the program may not exceed $10,000 for any fiscal year, and have a $50,000 per contract limitation.

Alternatives

After reviewing the significant concerns and issues identified by NRCS and interagency teams about the EQIP program, it was decided that several environmental concerns needed to be addressed in a set of alternatives. The alternatives included whether there should be a "general" approach covering large areas of the Nation or a concentrated geographic "priority area" approach for the program.

Alternative 1: No Action

The No-Action alternative recognizes that the four existing conservation programs (ACP, GPCP, WQIP, CRSCP) ceased to exist on April 4, 1996, with passage of the Farm Bill; an interim program extends until new rules are implemented. This alternative also assumes that no new program would replace those previously existing programs. Regulations require that a no-action alternative be analyzed. However, because Congress passed the 1996 Farm Bill mandating the implementation of EQIP, Alternative 1 is not an acceptable alternative.

Alternative 2: 100 % of Funds Targeted Only to Conservation Priority Areas

This alternative would target all EQIP funding exclusively to designated priority areas around the country. This would mean that EQIP funds could only be expended for conservation projects and activities that are conducted within designated priority areas. Conservation projects and activities which would fall outside the priority areas could not be funded.

Beneficial Effects

This alternative would place all EQIP funds, including livestock-related funds, exclusively in designated conservation priority areas. This would result in a concentration of funding in confined locations, although those locations could be very large in size as long as conservation efforts were being directed at similarly related natural-resource problems.

The concentration of funding would provide increased conservation efforts, which would be particularly advantageous to enhancing long-term, large-scale, natural-resource solutions on an ecosystem level. Cumulative environmental benefits would be restricted to those inside the priority areas, but those effects could be very effectively addressed.

Adverse Effects

Lack of Federal funding to areas outside of the priority areas may cause those areas to become degraded environmentally. Areas outside of priority areas that have been environmentally sustained through low levels of Federal funding over many years likely would now see a loss of environmental integrity. If areas, such as the Colorado River Salinity Control Program project areas, were not nominated and selected as "priority areas," existing conservation efforts to maintain water quality would likely falter and there could be adverse environmental effects to that ecosystem. In the case of the Colorado River, water quality will likely degrade, causing water entering Mexico to fall below agreed-upon water quality standards, and violating the 1974 United States treaty with Mexico.

Smaller-scale natural-resource problems outside the priority areas, especially relating to cumulative effects, such as water depletion, land conversions, and wildlife habitat, would not be addressed, possibly creating significant adverse environmental effects outside the priority areas.

Alternative 3. Majority of Funds Targeted to Priority Areas

This alternative would target the majority of funds to conservation priority areas, reserving a smaller portion for use with natural-resource priority concerns outside of priority areas.

Beneficial Effects

Targeting the majority of EQIP funds to priority areas and reserving a smaller portion for producers with natural-resource priority concerns outside priority areas allows funds to be allocated where they are most needed to address a variety of natural-resource situations. In particular, large-scale ecosystem problems can be addressed within priority areas, while smaller-scale projects and activities, whether inside or outside conservation priority areas also can be addressed, especially relating to cumulative effects. This approach gives large coverage across the landscape and allows conservation treatments to be effectively employed and tailored to particular ecosystem situations.

Since large-scale ecosystem efforts are able to be addressed, adverse cumulative effects of small-scale actions repeated many times in the priority area are able to be delineated, assessed, and recommendations made for correcting or treating the conditions.

Even if areas, such as the Colorado River Salinity Control Program project areas, were not nominated and selected as part of a "priority area," there could still be beneficial conservation enhancements to that ecosystem, because treatments could be applied outside of conservation priority areas.

With funds concentrated in a particular ecosystem and on specific natural resource problems, large environmental gains could be expected as a result of implementing this alternative not only because of the concentration of funds being directed at natural resource problems, but also because of the coverage of problems across the landscape.

Adverse Effects

There would be some "dilution" of the concentrated efforts in priority areas with this alternative because some funds would go to areas outside of priority areas, but those "dilution" effects would be small and would represent small environmental impediments when compared to overall environmental gains for the application of this alternative.

Alternative 4. Majority of Funds Targeted to Areas Outside of Conservation Priority Areas

Under this alternative, the majority of EQIP funds would not be concentrated in priority areas, but rather would be distributed to areas outside of conservation priority areas with a small amount reserved for priority areas.

Beneficial Effects

Under this alternative, emphasis is placed on the equitable distribution of funds across the Nation and across States to landowners and land users to apply conservation practices. In this uniform distribution approach, minorities and low-income populations would tend to benefit because virtually all producers are eligible for program benefits than might otherwise be the case with other approaches.

Adverse Effects

In reaching more people than might be possible with other approaches, the amounts of money given to each individual would tend to be limited and have an incrementally small effect environmentally. With only a small percentage of the funds under this approach going to fund remedies for large natural-resource problems, not many ecosystem-level, natural-resource problems can be addressed.

There is good coverage and dispersion of funds to the States under this alternative and there are some gains environmentally in the short-term. However, long-term conservation efforts are diluted. Adverse cumulative effects of small-scale actions repeated many times in the priority area are not able to be delineated and addressed. Large-scale ecological problems can be expected to worsen with this alternative.

Areas, such as the Colorado River Salinity Control Program project areas, likely would see environmental degradation because the concentrated correction efforts of the past would likely not be perpetuated with a wide distribution of funds. There would be adverse environmental effects to that ecosystem because of a lack of concentrated efforts. In the case of the Colorado River, water quality will likely degrade, causing water entering Mexico to fall below agreed-upon, water-quality standards and violating the 1974 United States treaty with Mexico.

Recommended Alternative

Alternative 3 is recommended to be implemented to initiate the Environmental Quality Incentives Program. The Environmental Assessment concluded that appropriate environmental analysis will be conducted for each conservation area to be submitted, cumulative effects assessed and addressed, all relevant environmental decision documents and negotiated program agreements in the former Colorado River Salinity Control Program areas must continue to be honored, Environmental Evaluations will be included in the planning for each contract, and environmental aspects will be part of the priority-area annual evaluations.

In the approach with environmental analysis being performed at the site-specific, priority-area level, and with appropriate mitigation applied where necessary, these actions are consistent with the National Environmental Policy Act (NEPA) and the program can be initiated in compliance with the 1996 Congressional Farm Bill mandate.

Findings

By concentrating the majority of funds to priority areas in accordance to Alternative 3, program planning can be aligned with ecosystem and participant needs and remedies. At the same time, for producers outside of priority areas, those basic environmental needs can be addressed to prevent environmental degradation that might otherwise occur.

By concentrating the majority of program efforts in priority areas, while addressing and maintaining other conservation concerns outside priority areas, cumulative environmental effects have the best opportunity to be addressed with alternative 3. With this alternative, adverse cumulative effects of small-scale actions repeated many times in the priority area can be effectively delineated and assessed, and reasonably achievable recommendations made for correcting or treating the environmental problems.

Alternative 3 offers the greatest environmental return for the Federal dollars spent, provides program managers and participants the greatest flexibility in program adaptability and administration, gives effective conservation coverage across the land, and involves a large number of participants.

Based on the Environmental Assessment summarized above, and with the recommended mitigation features included, I find that implementation of Alternative 3 of the Environmental Quality Incentives Program will not cause significant adverse effects on the quality of the human environment, and thus an Environmental Impact Statement is not required.

PAUL W. JOHNSON, Chief Natural Resources Conservation Service U.S. Department of Agriculture	Date

APPENDIX B - LIST OF PREPARERS

A Natural Resources Conservation Service Environmental Risk Assessment Team was formed to evaluate risks to the environment that could be addressed by implementing the 1996 Farm Bill's Environmental Quality Incentives Program. The following individuals comprised the team.

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APPENDIX C - COMPARISON OF ENVIRONMENTAL MANAGEMENT PROGRAMS

Under the Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994, effective October 13, 1994, the Secretary of Agriculture established the Farm Service Agency (FSA), and the Natural Resources Conservation Service (NRCS), abolishing the Agricultural Stabilization and Conservation Service and the Soil Conservation Service, respectively. The FSA is responsible for the administration of commodity programs funded through the Commodity Credit Corporation (CCC), as well as conservation programs. The NRCS is responsible for providing technical and financial assistance for natural resource conservation programs. Additionally, the Environmental Protection Agency, through the Non-Point Source Pollution Program (Section 319) and the U.S. Fish and Wildlife Service provide incentives for the installation of water quality and wildlife/wetland enhancement programs. The following provides a Comparison of the major environmental programs used to mitigate risk in the USDA and other Federal agencies.

Highly Erodible Land and Wetland Conservation (HELC/WC):
The Food Security Act of 1985, Subtitles B and C, as amended by the 1990 Food, Agriculture, Conservation, and Trade Act of 1990 and the Federal Agriculture Improvement and Reform Act of 1996 provides that after December 23, 1985, a program participant is ineligible for certain USDA program benefits for the production of an agricultural commodity on a field in which highly erodible land is predominant.

Additionally, the wetland conservation (WC) provisions of the 1985 Act provide that after December 23, 1985, a program participant is ineligible for certain USDA program benefits for the production of an agricultural commodity on a converted wetland, or after November 28, 1990, for the conversion of a wetland that makes the production of an agricultural commodity possible. Persons must be actively applying a conservation system in order to remain eligible for program benefits. Converted wetlands must have restoration of functions and values completed prior to restoration of program benefits.

The objectives of the HELC and WC provisions are to: reduce nonpoint source pollution from agricultural sources; reduce soil loss from wind and water erosion sources; protect the Nation's long-term capability to produce food and fiber; reduce sedimentation and improve water quality; and assist in preserving the functions and values of the Nation's wetlands.

Conservation Reserve Program (CRP):
Subtitle D of the Food Security Act of 1985, as amended, provides that the Secretary of Agriculture shall carry out a program for the purpose of the enrollment of highly erodible and environmentally sensitive lands in a conservation reserve program for the purposes of converting these lands to permanent vegetative cover.

The objectives of the CRP program are to reduce water and wind erosion; protect the Nation's long-term capability to produce food and fiber; reduce sedimentation; improve water quality; create better habitat for fish and wildlife; curb production of surplus commodities; and provided needed income support for farmers. Total acreage enrolled in the program at any one time has been established at 36.4 million acres through the year 2002. CRP is administered by the FSA with technical concurrence and assistance provided by NRCS.

Emergency Conservation Program (ECP):
The Emergency Conservation Program was authorized by Title IV of the Agricultural Credit Act of 1978, as amended. The purpose of the ECP is to assist eligible persons to rehabilitate farmlands damaged by wind and water erosion, floods, hurricanes, or other natural disasters and to provide water conservation or water enhancement measures during periods of severe drought. ECP is implemented by FSA, with technical assistance provided by NRCS.

Wetland Reserve Program (WRP):
The Food, Agriculture, Conservation, and Trade Act of 1990 established the Wetland Reserve Program November 28, 1990, as amended. The purposes of the WRP are for the voluntary restoration and protection of wetlands and associated lands. Cost-sharing assistance may be provided for activities that promote the restoration, protection, enhancement, maintenance, and management of wetland functions and values. NRCS administers this program.

Emergency Wetland Reserve Program (EWRP):
Authorized in 1993 under emergency supplemental appropriations for the midwestern floods, this program provides easement payments and restoration cost shares to landowners who permanently restore wetlands on cropland for which the cost of cropland and levee restoration exceeds the fair market value of the food-affected cropland. EWRP operates in seven Midwestern States.

Water Bank:
This program was authorized in 1970 and provides for making annual per-acre payments to landowners who agree not to burn, drain, fill, or otherwise destroy the character of enrolled wetland areas in contracts not to exceed 10 years.

Conservation Farm Option (CFO):
The Conservation Farm Option was established by the Federal Agriculture Improvement and Reform Act of 1996. The purpose of CFO is to establish a pilot program for producers of wheat, fed grains, cotton, and rice to allow persons to contract eligible acreage enrolled in the Agricultural Market Transition Program established under the Agriculture Market Transition Act (AMTA). Conservation contracts shall be implemented that include resource-conserving crop rotations, and other conservation practices. This program is jointly administered by NRCS and FSA.

Program objectives include: the conservation of soil, water, and related resources; water quality protection or improvement; wetland restoration, protection, and creation; wildlife habitat development and protection; or other similar conservation purposes.

Wildlife Habitat Incentives Program:
This program was established under the Federal Agriculture Improvement and Reform Act of 1996 for the purpose of providing technical and financial assistance to landowners to develop upland wildlife, wetland wildlife, threatened and endangered species, fish and other types of wildlife habitats through the purchase of conservation easements. This program is administered by NRCS.

Integrated Farm Management Program:
This program was established under the Food, Agriculture, Conservation, and Trade Act of 1990, as amended and is for the purpose of assisting producers of agricultural commodities in adopting integrated, multiyear, site-specific farm management plans that utilize resource-conserving crop rotations. Resource-conserving crops include legumes, legume-grass, and legume and small grain mixtures, and Combinations of the three, as well as alternative crops if designated by the Secretary.

Conservation of Private Grazing Lands:
This program was established by the Federal Agriculture Improvement and Reform Act of 1996 for the purposes of providing a coordinated technical, educational, and related assistance program to conserve and enhance private grazing land resources. The program establishes a coordinated and cooperative Federal, State, and local grazing conservation program for the management of private grazing land; strengthens technical, educational, and related assistance programs that provide assistance to owners and managers of private grazing land; provides for the conservation and improvement of wildlife habitat on private grazing land; provides for conserving and improving fish habitat and aquatic system through grazing land conservation treatment; provides for the protection and improvement of water quality; provides for the improvement of the dependability and consistency of water supplies; provides for the identification and management of weeds, noxious weeds, and brush encroachment problems on private grazing lands; and provides for the integration of conservation planning and management decisions by owners and managers of private grazing lands, on a voluntary basis. This program is administered by NRCS.

Environmental Easement Program:
The environmental easement program was established in 1990 to acquire easements on eligible farms or ranches to ensure the continued long-term protection of environmentally sensitive lands or reduction in the degradation of water quality on farms and ranches through continued conservation treatment and improvement of soil and water resources. This program is administered by FSA, with technical assistance provided by NRCS.

Forestry Incentives Program (FIP):
This program was initiated in 1975 as a separate program to provide cost-sharing assistance for tree planting and timber stand improvement for private forest lands of no more than 1,000 acres. The program is administered by NRCS in coordination with the U.S..Forest Service.

Forest Stewardship Incentives Program (SIP):
This program was enacted in 1990 and is administered by the U.S. Forest Service to provide grants to State forestry agencies for expanding tree planting and improvement and for providing technical assistance to owners of nonindustrial private forest lands in developing and implementing forest stewardship plans to enhance multi-resource needs.

Resource Conservation and Development Program (RC&D):
RC&D was authorized by Public Law 97-98. The purpose of the program is to encourage and improve the capability of State and local units of government and local nonprofit organizations in rural areas to plan, develop, and carry out programs for resource conservation and development. Purposes of the program include land conservation; water management; community development; and environmental enhancement. Eligible on-farm practices include the treatment of critically eroding areas. NRCS administers this program.

Emergency Watershed Protection Program (EWP):
This program, initiated in 1950 is administered by NRCS. The program provides technical and financial assistance to local institutions for removal of storm and flood debris from stream channels and for the restoration of stream channels and levees to reduce threat of loss of life and property.

Small Watershed Program (Public Law 83-566):
This program was authorized in 1954 by the Watershed Protection and Flood Prevention Act, Public Law 83-566. The purpose of the program is to provided technical and financial assistance for planning and implementing projects to protect, develop, and utilize the land and water resources in watersheds of less than 250,000-acre drainage area.

Technical and financial assistance can be provided to plan and install on-farm practices that provide for improvement in the natural resources (soil, water, air, plants, animals, and human). Watershed plans are developed to solve identified resource problems. The program is administered by NRCS.

Non-Point Source Program:
This program was established by Section 319 of the Clean Water Act, and is administered by EPA. It provides for the identification of navigable waters that cannot attain water quality standards without reduction of non-point sources of pollution. The program authorizes grants to States for the development of management plans, and for the implementation of best management practices by agricultural producers, including animal waste management systems.

The Clean Lakes Program:
This program is administered by EPA, as authorized by section 314 of the Clean Water Act. It authorizes EPA to provide grants to States for lake classification surveys, diagnostic/feasibility studies, and for projects to restore and protect lakes, including assistance to farmers in controlling non-point sources through the clean lakes demonstration program.

The National Estuary Program:
This program was established by Section 320 of the Clean Water Act and provides for the identification of nationally significant estuaries that are threatened by pollution. It provides grants to States to carry out management plans, and to provide technical and financial assistance to farmers in designated areas.

Partners for Wildlife Program:
This program is administered by the U.S. Fish and Wildlife Service, in cooperation with State and local agencies and groups to improve and restore wildlife habitats and wetland areas. The funds are administered through grants to State agencies, and can be partnered with funds from non-profit environmental groups such as Ducks Unlimited.

APPENDIX D - GLOSSARY

Agricultural Commodity	Any crop planted and produced by annual tilling of the soil, including tilling by one-trip planters, or sugarcane.
Agricultural Land	Land that is intensively used and managed for the production of food and fiber. Examples are cropland, hayland and pastures, including native pastures and rangeland, orchards, vineyards, areas which support wetland crops (i.e. cranberries, taro, watercress, or rice), other lands used to produce or support the production of livestock, and small tree farms.
Assessment Endpoint	An explicit expression of the environmental value that is to be protected. An assessment endpoint includes both an ecological entity and specific attributes of that entity.
Characterization of Ecological Effects	A portion of the analysis phase of the ecological risk assessment that evaluates the ability of a stressor to cause adverse effects under a particular set of circumstances.
Comparative Risk Assessment	A process that generally uses an expert judgment approach to evaluate the relative magnitude of effects and set priorities among a wide range of environmental problems. Some applications of this process are similar to the problem formulation portion of an ecological risk assessment in that the outcome may help select topics for further evaluation and help focus limited resources on areas having the greatest risk reduction potential.
Conceptual Model	A model which describes a series of working hypotheses of how the stressor might affect ecological components. The conceptual model also describes the ecosystem potentially at risk, the relationship between measures of effect and assessment endpoints, and exposure.
Conservation Management System	A generic term that includes any combination of conservation practices and management that achieves a level of treatment of the five natural resources that satisfies criteria contained in the NRCS Field Office Technical Guide, such as a resource management system, or an acceptable management system.

Conservation Impacts	The differences between anticipated effects of treatment in comparison to existing or benchmark conditions. Differences may be expressed by narrative, quantitative, visual, or other means. Impacts are used as a basis for making informed conservation decisions.
Conservation District	A subdivision of State, Indian Tribe, or territory organized pursuant to the State soil conservation district law, as amended. These may be called soil conservation districts, soil and water conservation districts, resource conservation districts, land conservation committees, or natural resource districts.
Conservation Plan	A set of decisions made to achieve one or more objectives. The document presented to the client summarizing the decisions to manage resources. The document can be the basis for long-term contracts for implementing the plan. It also includes the requirements for operation and maintenance.
Conservation Practice	A specific treatment, such as a structural or vegetative measure, or management technique commonly used to meet a specific need in planning and carrying out soil and water specifications for conservation programs for which standards and specifications have been developed. Conservation practices are in section IV of the FOTG, which is based on the National Handbook of Conservation Practices (NHCP).
Conservation Tillage	Any tillage and planting system that maintains at least 30 % of the soil surface covered by residue after planting to reduce soil erosion by water; or where soil erosion by wind is the primary concern, maintains at least 1,000 pounds (per acre) of flat, small grain residue equivalent on the surface during the critical wind erosion period. Two key factors influencing crop residue are: the previous crop, which establishes the initial residue amount and determines its fragility; and the type of tillage operations prior to and including planting.
Crop Residue	That matter which is left on or incorporated in or near the soil surface following the harvest of a crop. An example of a crop residue is corn stalks or wheat stubble.

Crop Residue Management	A conservation practice that usually involves a reduction in the number of passes over a field with tillage implements and/or in the intensity of tillage operations, including the elimination of plowing (inversion of the surface layer of soil). This practice is designed to leave sufficient residue on the soil surface to reduce wind and/or water erosion. The practice is a year-round system that includes all field operations that affect the amount of residue, its orientation to the soil surface and prevailing wind and rainfall patterns, and the eveness of residue distribution throughout the period requiring protection. This may include the use of cover crops where sufficient quantities of other residue are not available to reduce the vulnerability of the soil to erosion during critical periods.
Cultural Resources	All of the activities, accomplishments, and artifacts of people throughout time. The most common are sites, buildings, structures, and objects that have scientific, historical, or archaeological value.
Cumulative Ecological Risk Assessment	A process that involves consideration of the aggregate ecological risk to the target entity caused by the accumulation of risk from multiple stressors.
Ecological Risk Assessment	The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors.
Ecosystem	The biotic community and abiotic environment within a specified location in space and time.
Ecosystem Management	The appropriate integration of ecological, economic, and social factors to maintain and enhance the quality of the environment to best meet our current and future needs.
Environmental Impact Statement	Assessments required under the National Environmental Policy Act (NEPA) to fully evaluate environmental effects associated with proposed major Federal actions.
Erodibility Index	A numerical value that expresses the potential erodibility of a soil in relation to its soil loss tolerance value without consideration of applied conservation practices or management. The soil erodibility index (EI) is the measure selected to determine whether a soil map unit is highly erodible.

Field Office Technical Guide	The official NRCS guidelines, criteria, and standards for planning and applying conservation treatments for each of the five resources. The FOTG contains technical information, important conservation considerations for each resource, resource quality criteria for treatment levels, NRCS practice standards for the conservation of soil, water, air, plant, and animal resources, and information on the effects of applied conservation treatments. The guide specifically applies to the working area of the field office. It is developed and maintained for use by field office employees in helping clients in resource conservation planning and implementation.
Forage Production	Production of grasses, legumes, or other forage on pasture and hayland. Includes planting, grazing, haying, or harvesting.
Highly Erodible Land	Land that has an erodibility index of 8 or more. It includes cropland in fields that have at least one-third or 50 acres (whichever is less) of highly erodible soils. These are soils with a natural erosion potential at least 8 times their tolerance (T) level.
Hydrologic Unit	A drainage basin or watershed that collects and discharges its surface streamflow through one outlet or mouth, typically implying a topographic divide. May also include an aquifer or its recharge areas that may cross one or more topographic divides. Can also consist of a contiguous area (such as an irrigation or a drainage district). An island of limited size may also be a hydrologic unit.
Implementation	The act of installing planned conservation treatment and management measures that are documented in plans and case files. Includes enacting measures called for in natural resource plans, such as flood plain zoning and sediment and erosion control ordinances.
Integrated Pest Management	The optimization of pest control in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage below the economic injury level while minimizing hazards to humans, plants, and the environment.
Measure of Effect	A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint.
Measure of Ecosystem and Receptor Characteristics	A measurable characteristic of the ecosystem or receptor that is used in support of exposure or effects analysis.

Measure of Exposure	A measurable stressor characteristic that is used to help quantify exposure.
National Environmental Policy Act	The 1970 Act that requires Federal agencies to consider the effects on the environment of proposed Federal actions. This act established the requirement for the Environmental Impact Statement.
Natural Resource	Any naturally recurring resource needed by an organism, population, or ecosystem. NRCS applies this term to soil, water, air, plants, and animals.
Offsite	Locations outside boundaries of the land unit for which conservation treatment or other actions are being considered or evaluation is being made.
Onsite	Locations within the boundaries of the land for which conservation treatment or other actions are being considered, or evaluation is being made.
Palustrine Wetland	This type of system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: 1) an area less than 20 acres; 2) active wave-formed or bedrock shoreline features lacking; 3) water depth in the deepest part of the basis less than 2 meters at low water; and 4) salinity due to ocean-derived salts less than 0.5%.
Planning Process	The nine-step process NRCS uses to help clients plan and apply conservation treatments or make land use and treatment decisions.
Pollutant	Any naturally occurring or introduced substance that limits the use of a resource for a specific purpose.
Receptor	The ecological component exposed to the stressor.
Relative Risk Assessment	A process similar to comparative risk assessment. It involve estimating the risks associated with different stressors or management actions.

Resource Management System	A combination of conservation practices and management identified by land or water uses that, when installed, will prevent resource degradation and permit sustained use by meeting criteria established in the FOTG for the treatment of soil, water, air, plant, and animal resources.
Resource Setting	A description of environmental characteristics, land use, and management important for comparison of resource information among planning units. Such background information also provides better understanding of the relative magnitude of resource problems. An adequate description may include such information as dominant soils, range sites, important topographic or geomorphic characteristics, Major Land Resource Areas, precipitation patterns, seasonal land use, climate, current resource conditions, type of operation, and relationships to streams, lakes, and aquifers.
Soil Loss Tolerance	The tolerance (T) value is the rate of soil erosion above which long-term soil productivity may be depleted.
Source	An entity or action that releases to the environment or imposes on the environment a chemical, physical, or biological stressor or stressors.
Stress Regime	The term to describe the series of interactions of exposures and effects resulting in secondary exposures, secondary effects, and finally, ultimate effects or causal chain, pathway, or network.
Stressor	Any physical, chemical, or biological entity that can induce an adverse response.
Stressor-Response Profile	The product of characterization of ecological effects in the analysis phase of ecological risk assessment. The stressor-response profile summarizes the data on the effects of a stressor and the relationship of the data to the assessment endpoint.
Treatment Standard	An established criterion that must be met by an identified conservation treatment before it will be accepted by NRCS as solving a resource problem.
Trophic Levels	A functional classification of taxa within a community that is based on feeding relationships.